THE ART OF ARGUING SCIENCE

A CRITIQUE OF SCIENTIFIC RHETORIC THROUGH THE INVASIVE SPECIES NARRATIVE

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by

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ABSTRACT

The Art of Arguing Science: A Critique of Scientific Language and Rhetoric Through the Invasive Species Narrative

Clare Follmann

My thesis asks, what are the foundations, implications and effects of misleading metaphors and inaccessible language in invasive species management nomenclature? I performed close readings of a diverse range of historical and contemporary texts on language and linguistic theory, science and scientific communication, and nomenclature used in invasive species management. For my data collection, I focused on quantifying a particular class of inaccessible "plastic" words in invasive species management. I wanted to find out if they existed in invasive species management and to what extent, what effects they have on a broad audience, and what invasive species management would look or feel like without plastic words or militarized metaphor. Therefore, I analyzed a selection of six key texts on invasive species to discover extant usage of 'plastic' words. I sent a portion of one of the key texts to an intended diverse audience of 100+ individuals accompanied with a survey designed to determine read-difficulty of the text portion. I also conducted an interview with a 'science translator'. After collecting this data, I performed my own original translation of the portion of the text I sent to be surveyed. The results of this data and research suggests that invasive species management relies both on militaristic metaphor as well as inaccessible words to generate a narrative that is misleading, persuasive, unclear, and difficult for most people to argue against. A significant number of responses found use of terms difficult to pin down, because of their malleability. Malleable and variable terms are the main source of confusion in science communication. Plastic words, when used in invasive species management, have the effect of colonizing the rest of the document in a noticeable way. Even when eliminated, the feeling of the plastic words remained. In light of a changing climate that challenges the narrative of invasive species as militarized enemy other invading the pristine, we are called to question this narrative and seek an alternative story, one in which many voices are able to be heard. This case study can serve as a metonym, a small piece of something larger, for science as a whole. Science should be democratized, space should be made for subverted voices, and narratives of widespread phenomena should, to the best of our ability, be written by many people with many perspectives, experiences, ideas and solutions. A democratic science with accessible communication would dismantle barriers to changing bettering the world we live in.

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Chapter 1: Introduction.

> Speech is a spell, and words, once ejected into the air, warp the weave of worlds.
> –Ho Tzu Nyen

My thesis exposes under-examined norms of scientific discourse with a focus on the nomenclature of invasive species management. To build my thesis, I analyzed the language and rhetoric that is used to talk about invasive species management, closely reading its metaphors as well as examining the frequency of use and effects of inaccessible terminology, specifically 'plastic words'. While I do not discount the negative effects of invasive species, I seek to critically evaluate the ways in which scientific and bureaucratic rhetoric promote narratives that can prevent holistic approaches to, and broad public engagement with, a range of ecological topics. The lexicon of invasive species management functions as a metonymic case study from which I draw general conclusions about the pitfalls of forms of discourse that objectify, obscure, oversimplify or instrumentalize complex topics. This thesis draws from a range of discourses and texts and is interdisciplinary in its approach. By engaging with my topic in an interdisciplinary manner, I am endeavoring to avoid the narrow viewpoint that can result from remaining within silos of disciplinary work. Interdisciplinarity serves to promote reflexivity and holistic appraisal.

I do not mean to suggest that invasive species are not harmful. I do not mean to suggest they do not contribute to biodiversity loss and other environmental damages. I mean to explore how the prevalent story of invasive species is being told, and the ways in which relying on misleading persuasive rhetoric of militaristic metaphors and the surreptitiously inaccessible language of plastic words can be a disservice to all, and can

actually undermine efforts to teach about and protect against the harm caused by invasive species. Any way of thinking that is discordant to conventional opinion has little traction in the invasive species story that is currently being told. My thesis explores *why*.

Metaphors and Plastic Words

Metaphors are rhetorical devices that simplify complex issues by comparing those issues to more familiar topics. To use a metaphor to describe a metaphor: metaphors are linguistic alchemy. They have the effect of rhetorically turning one thing into something else. If used thoughtlessly, metaphors can organize and structure thought and discourse in unintended and unconscious ways. *Metaphors*, as referenced in the Oxford English Dictionary (OED) are defined as 1) "A figure of speech in which a name or descriptive word or phrase is transferred to an object or action different from, but analogous to, that to which it is literally applicable; an instance of this, a metaphorical expression", and 2) "Something regarded as representative or suggestive of something else, esp. as a material emblem of an abstract quality, condition, notion, etc.; a symbol, a token. Frequently with for, of" ("metaphor, n", 2018). The etymology of the word originates from the Greek *metepherein* meaning *to transfer* where *meta* means over or across, and *pherein* means to carry or bear ("metaphor, n", 2018).

Plastic words do not have an entry in the OED. German linguist and philosopher Uwe Poersken coined this term in his book *Plastic Words: The Tyranny of Modular Language* (2004) to describe a list of 30 or so words that share a remarkable set of characteristics (See Appendix 1). There is also no recipe-like definition for plastic words that can be found in his text, but we can find in his introduction a loose exploration of

their concept. Poersken describes them as having, “been fashioned for the purpose of laying down the tracks and outlining the routes of a civilization that is covering the globe with gathering speed. Their origins can no longer be discerned. They resemble one another” (Poersken, 2004, p. 1). He explains that “they may not be noticed, but they are present everywhere”, and that “they invade private conversation. When they first appear, they are fashionable and command attention; but they merge with the everyday and soon seem commonsense” (Poersken, 2004, p. 1). This is how they show up and how they dig their heels into our tongues, and comfortably settle in. Their effects are contingent on their pervasiveness, combined with the malleability, or *plasticity*, of their meaning. Plastic words originated in the vernacular, were adopted by science, and then snuck their way back into the vernacular. By vernacular, I mean the common, colloquial language used by people in everyday conversation. As they circulate and migrate, the meanings of these plastic words change: they have the mutability of plastic. They are flexible enough to be used in a variety of different disciplines, or can refer to a wide range of different concepts. They can mean many things (or nothing) at once, and whoever uses them gets to choose what they mean. They can mean their very inverse when used in a different context. Because they are overarching, they render different, more specific words obsolete. They are difficult to argue against because they are so familiar. Most people have a general idea of their meaning, but it is hard to know exactly what is being said when they are used. They are able to render opposing points of view ineffective or obsolete because they cast such a broad stroke, eliminate specificity in synonyms, and feel official. Poersken, in describing the plastic word “sexuality” explains the characteristic of plastic words that I am chiefly concerned with: “The word signals

science. It silences" (Poersken, 2004, p. 15). For these reasons of variability, ahistory and their silencing effects, I refer to them as inaccessible.

What is at stake when indeterminable words such as these are used? Using these words thoughtlessly degrades our ability to be reflexive or self-reflective, and works against accountability and responsibility. This is because they feel inarguable. When used by institutions that hold power over our daily lives, they can be tyrannical. These words are used assertively, do not lend themselves to inquiry, and do not make room for improvement or alternate ideas. They slip under the radar. The familiarity they have on our tongue and in our minds makes it hard to notice them. These words, when used in various narratives make it very difficult to open up conversation or to offer alternative narratives. Plastic words, and their evocative meanings are modern and historically unprecedented.

When plastic words are used in conjunction with persuasive metaphors to tell a science story, the effect can be such that an audience is made to believe in an oversimplification without being given any space or opportunity to interject or dialogue meaningfully.

Invasive Species Management

The term *invasive species management* contains both a metaphor and a plastic word.

The metaphor lies within the word *invasive* and conjures militaristic ideas of an invading other, an enemy, or war. Biologist Charles Elton coined the term *invasive* in his book *The Ecology of Invasions by Animals and Plants* (1958) to refer to specific non-

native species that harm the native regions into which they migrate. Elton wrote this in a post-war era United States, and the text is filled with militant metaphoric terminology to refer to this type of species.

The plastic word is *management*, and shows up in Poersken's list of 30 plastic words. Management is a marriage of the prefix *manage* and the suffix *ment*. *Manage* comes from the Italian *maneggiare*, from *mano* which meant hand, and which comes from the Latin *manus. Maneggiare*, when used in the mid-16th century, originally meant *to handle*, specifically, to handle or train a horse. Related is the Spanish *manejar*, meaning to use or manipulate. Early use of the word management implied manipulation or trickery ("manage, v", 2018). When used in the context of invasive species management, most often it means something like *control* or *diminish* or *eradicate*. However, several usages are not so clear. Here, I refer to several documents I use in my data collection and analysis (See Appendix 3-8). For example, in the *Five-Year Review of Executive Order 13112 on Invasive Species* (2005), there are references to "Control and Management" which seems redundant because *control* and *management* here seem synonymous (NISC, 2005, p. 8). This is right above "Information Management/Research" (NISC, 2005, p. 8) and later "information management sharing and accessibility" (NISC, 2005, p. 16) where the term management is difficult to determine in context, but likely refers to a controlled release of information. In *The Standard Operating Procedures for the Rapid Screening of Species' Risk of Establishment and Impact in the United States* (2016) there are instances of "data management" (U.S Fish and Wildlife, 2016 pp. 13, 23), where the exact meaning of manage is harder to discern. In the *Executive Order 13751* (2016), there's instances of

"Office of Management and Budget" ("E.O. 13751", 2016) but again I cannot discern the exact distinct meaning here, because budget should suffice and also seems synonymous with management. In *Executive Order 13751 Safeguarding the Nation from the Impacts of Invasive Species* (2016), a Management Plan of 2016 is revealed, but this plan encompasses many different ideas, including:

> (1) provide institutional leadership and priority setting; (2) achieve effective interagency coordination and cost-efficiency; (3) raise awareness and motivate action, including through the promotion of appropriate transparency, community-level consultation, and stakeholder outreach concerning the benefits and risks to human, animal, or plant health when controlling or eradicating an invasive species; (4) remove institutional and policy barriers; (5) assess and strengthen capacities; and (6) foster scientific, technical, and programmatic innovation ("E.O. 13751", 2016).

While some ideas of what management refers to in this context can be discerned through the haze (ie: control of, minimization of, eradication of, education of, etc), when we reach to grasp for a concrete meaning, it is as if the word jumps away to signify something else altogether. It serves as a placeholder for whatever the *management* will be at any moment. We see also in these soundbites a handful of other plastic words (plan, information, health, etc) with obscure intonations that contribute to a generally vague intention for invasive species management**.** Further, one need only look into another sub-discipline of science to be made clearly aware that management (as like any other plastic word) is a master of disguise, with multiple diverse personalities. In the realm of economics, for example, manage rarely refers to eradication or minimization. We can see different implications for the word *management* in the *Federal Trade Commission Draft Strategic Plan* (2017):

> Major Management Priorities and Objectives The FTC's management objectives are incorporated into Strategic Goal 3, Advance the FTC's performance through excellence in managing resources, human capital, and information technology. This Strategic Plan addresses priorities in areas of human capital management, information technology management and planning, financial and acquisition management, staff emergency preparedness, records management and ethics.

Here, the meaning of manage or management generally refers to stimulation, advancement and encouraged growth, rather than minimization or eradication which is largely the preferred meaning for management in the invasive species context. In this comparison, these meanings of management contradict each other, deflating each antonymic meaning.

The discourse of invasive species management as a whole relies on plastic words and metaphors. By means of militaristic metaphors and inaccessible plastic words, invasive species management can at once mask and promote its goals, creating an inherently biased and actually contingent perspective against those species deemed invasive—a perspective that is made to seem unquestionable, eternal and universal.

To gather data for this thesis, I researched the frequency of plastic words used in invasive species management by coding a selection of federal documents designed to explain invasive species and invasive species management to the public in order to determine if, and to what extent, plastic words existed in invasive species management. I analyzed the results of a survey I created in order to explore how easily a diverse range of people could read and understand a small section of a key text on invasive species, to see how plastic words may or may not effect comprehension of the document. I interviewed a "science translator" whose job was to translate technical scientific data and results into

text that aspired to be accessible to the general public, and taking what I learned from this interview, I rewrote the portion of the seminal invasive species document which my survey participants evaluated. In my translation I eliminated plastic words, metaphors, and abstraction to the best of my ability to find out how invasive species management would feel and sound without problematic language and rhetoric.

I have found that the use of plastic words in this specific sub-discipline of science is under examined: plastic words have never been quantified in invasive species management, nor, for that matter, in nearly any sub-discipline of science. My work draws on existing analyses of military metaphors and pushes it further by comparing metaphor and plastic words and examining how both these modalities of language combine to promote a single way of thinking about an ecologically important phenomenon which, I argue, should be understood and addressed holistically, accessibly, and democratically.

Much like how statistical analysis of a small portion allows for generalizations to be made about a population, my work is similarly metonymic in nature. It is to provide an in-depth analysis of a small piece that speaks for and represents something much larger. It's a case study for science as an institution of power that influences how people think—about ourselves, each other, and the world around us. In short, my work notes that language should be used accessibly, thoughtfully, and very carefully, especially in institutions of power. My work argues that science should be aware of its power and be made humbler to allow space for alternative tastes, solutions and ideas.

The planet is undergoing a dramatic shift under the wake of anthropogenic climate change. Many of our preconceived paradigms are being thrown into question as

climate change alters our world. This ecological world shift offers us a unique opportunity to change sedentary worldviews, and asses these and similarly prominent narratives in favor of more holistic and thoughtful paradigms, in which many, and not few, may have a voice that is heard *and* taken into consideration. Climate change offers us a chance to build a more democratic science.

Layout of Thesis

In Chapter two, the literature review, I examine the historical roots of scientific language and, specifically, how scientific discoveries and nomenclature often reflect and express societal beliefs and norms of their era. I discuss language theory and semiotics, history and philosophy of science communication, and explore the implications of metaphor and plastic words in scientific discourse with supporting literature on uses of militaristic metaphors in invasive species management.

In Chapter three, the methods section, I describe my methods, including how I chose and coded key documents for the recursion and frequency of key terms. Under methods, I also include my informal interview with a science translator.

In Chapter four, the results and analysis section, I present a quantitative, qualitative and humanist analysis of my surveys, coding, and interview. This chapter begins exploring patterns.

In Chapter five, the discussion, I unpack these patterns, interpreting their implications. This section includes my own translation of a key invasive species document. I also discuss practical ways to avoid abstract language, and offer suggestions for future work.

In my conclusion, Chapter six, I explore and challenge the undemocratic effects of the preferred English language of science.

Chapter 2: Literature Review

> Words are not bound directly to other pictorial elements. They are merely inscriptions on blobs and shapes.
>
> – Michel Foucault

Language and Semiotics

Before diving into this thesis, I think it is important to layout the seminal literary framework of semiotics. The linguistic structures of semiotics are indirectly referenced throughout this thesis, and in a sense, form the basis of my linguistic critique.

Semiotics comes from the concept of *semiosis*, which, at the core, describes the relationship between *sign*, the *signifier*, and the *signified*. The Oxford English Dictionary (OED) defines semiotics as "The science of communication studied through the interpretation of signs and symbols as they operate in various fields, esp. language" ("semiotics, n", 2018). There are two key figures in the semiotic theory—Ferdinand de Saussure (1857-1913) and Charles Peirce (1839-1914). Saussure's work is foundational for semiotics linguistics, and Peirce elaborated on Saussure's ideas. According to Saussure, the *signifier* is an indicator which is understood to represent or suggest the *signified*. The *sign* is the name given to this relationship of *signifier* which is *signifying* the *signified*. For example, the word "pipe", or a photograph, painting or drawing of a pipe represents or suggests the concept of what a pipe is. The word, and the artful rendering (photo, painting, drawing) are the *signifier* and the concept of a pipe is the *signified*, while the *sign* is the relationship between the word or artful rendering and the concept. Another form of signifier for a pipe could be that syrupy pungent smell unique to pipe tobacco smoke. Each of these signifiers do not refer to any specific pipe, but

rather the general idea of what a pipe is. Pierce elaborated on these distinctive signifiers—noticing that while they may signify the same thing, they have each a distinctive nature. He argues that there are three types of signifiers: *icon, index*, or *symbol*. An *icon* will be a similar rendering of the signified, for example: that painting, photograph or drawing of our pipe. An *index* will be something that is concurrent to or caused by the signified, for example: the smell of pipe tobacco and smoke. A *symbol* is only able to work as a signifier because of widespread agreement or convention that it will signify the signified (Sebeok, 2001). For example, the word, "pipe", which has no relationship to what a pipe is inherently, is recognizable (at least by those who can read English) as signifying an actual pipe. Both icon and symbol are arbitrary, meaning they do not have a tangible connection to the signified. Rather, we can recognize the icon and the symbol as a signifier because our culture connects these forms of signifiers to the signified. For example, a cat may look at a painting or photograph of a pipe, but will probably not make any discernable connection between the painting or photograph and the actual pipe. However, a cat might smell pipe tobacco and know then that there is the source of the smell, the pipe, somewhere. An index is not arbitrary.

Semiotician Roland Barthes argues that words have three dimensions: "a cultural reference, a rhetorical model, a deliberately ambiguous utterance and a simple indicative unit" **(**Newton, 1997, p. 95**).** In short, words are not that which they represent. They are the signifier "symbol", signifying the signified. They are "rose", suggesting this fragrant, pretty, spiral, many-petaled, dew-touched, sharp-stemmed historically and culturally charged romantic flower. Semiotics tells us that a language is a system of meaning. There

is no objective meaning, only nuanced and layered meaning within the many-layered context of language which is particular to that language's culture.

Figure 1: A Digital Copy of Rene Magritte's Painting: Treachery of Images

To elaborate more intently on semiotics, we can refer to the Rene Magritte's painting *This is Not a Pipe,* which is depicted above, as well as an essay of the same name by philosopher Michel Foucault (1926-1984). In James Harkness' introduction to his translation of Foucault's *This is Not a Pipe* (1982), Harkness explains pivotal points of semiotics, referencing often the significance of Rene Magritte's surreal painting. Harkness writes:

> In Saussurean linguistics, words do not 'refer' to things themselves. Rather, they have meaning as points within the entire system that is a language-a system, further, conceived as a network of graded differences. 'Dog' is not somehow attached to the real animal, arising naturally from it and participating magically in its essence or presence. Instead, 'dog' has conceptual signification insofar as it evokes an idea that differs from the idea of a cat, a bear, a· fur seal, etc. It has syntactical signification insofar as it (a noun) differs from words such as 'bark' (verb) or 'furry' (adjective) and thus cannot take their places in a proposition; and it has phonetic signification insofar as it differs from more or less similar sounding signifiers such as 'bog,' 'dot,' 'dig,' and so on. From the commonsense vantage this seems an unnecessarily complex and circumlocutory approach to language, aimed at the most radical divorce possible between words and things. And why bother? After all, would anyone seriously argue that a word is what it represents-that the painting of a pipe is the pipe itself? …Yet it is exactly from the commonsense vantage that, when asked to identify the painting, we reply 'It's a pipe'-words we shall choke on the moment we try to light up (Foucault, 1982, p. 5).

Harkness here elaborates on how arbitrary icons and symbols are. Words and language are symbols, and only are able to operate successfully within a complex system of meaning, history, shared understanding—culture. Because words work within language, and language works within culture, words carry the weight of culture, society, story and history. Yet it is so often difficult to remember that these symbols and icons are arbitrary, and we choke on our words, Harkness suggests, as we try to light up this painting of the pipe, calling it "pipe" when it is really just a painting. Harkness reminds us not to forget

there is no tangible connection between icons and symbols and what they signify. As we remember this, we are made to recognize how incredibly powerful words and language are to convince us that this arbitrary phantom connection is real.

The theory of semiotics is visible in both the concept of metaphor and of plastic words. In *Eros the Bittersweet: An Essay* (1986) poet Anne Carson describes how semiotics shapes the way we think about metaphor:

> There is in the mind a change or shift of distance, which Aristotle calls an epiphora (Poet. 21.1457b7), bringing two heterogeneous things close to reveal their kinship. The innovation of metaphor occurs in this shift of distance from far to near, and it is effected by imagination. A virtuoso act of imagination brings the two things together, sees their incongruence, then sees also a new congruence, meanwhile continuing to recognize the previous incongruence through the new congruence. Both the ordinary, literal sense and a novel sense are present at once in the words of a metaphor; both the ordinary, descriptive reference and a novel reference are held in tension by the metaphor's way of looking at the world (Carson 1986, p. 73)

Metaphors construct new semantic relationships between disparate things. *Epiphora* bridges differences. Similarly, semiotics tells us we are uniting a thing—be it that which we sit upon, often accompanied by a flat object of similar height (*chair, table*), that which we feel when we are near someone we care so very much for (*love*), that which we pick, hold in our hands, smell, give to someone we care so very much for, stop to smell to take a moment out of our busy days, that into which the bees fly (*rose)*—*something,* to a word made of letters made up of spaces, lines, dashes and dots that we decide will be that something's name.

Uwe Poersken explains the ways in which plastic words *signify* and the ways in which they *mean*. He writes:

> So, do 'development' and 'sexuality' mean the same thing? It seems to me that they signify different things, but what they signify is less important than what they mean. And the meaning is the same. These are close relatives of the myths of everyday life by Roland Barthes. They are idols, magical and empty (Poersken, 2004, p. 23).

Here, we grapple with the concept of different words signifying different things, and actually *meaning* the same thing. What these plastic words mean, however, is everything and nothing at the same time. What they mean is *science*. They mean *authority*. They mean *believe this.* While plastic words refer to various things, they share in common a kind of meaning that is evacuated. Rather than create new meanings, adding to our understanding, as metaphors do, plastic words seem to diminish our understanding and perception, functioning mechanically and invisibly, failing to call our attention to meaning-making at all, as if stand-ins or placeholders.

Barthes addresses this function of certain words at the end of his essay "Science versus Literature" (1997). He writes: "On the one hand and first there is the content of the scientific message, which is everything, on the other hand and next, the verbal form responsible for expressing that content, which is nothing…" (Barthes, 1997, p. 95). Because they carry the sound of science and authority, plastic words have unique power. Because the meaning changes as it is handed over from mouth to mouth of the powerful, these words mean nothing. Because they mean nothing, they can mean everything and they can mean *anything*.

We can sense the reality of semiotics when thinking of translations. You can say rose in one language and it will never carry over absolutely the nuanced many-layered Juliet-Romeo start-crossed cultural meanings into another. Plastic words, however, carry over almost seamlessly from language to language, with nearly infinite references inside the system of meaning. On the first page of Poersken's introduction to his essay, Poersken describes a conference, in which "discussion was dominated by a number of words that floated through it like driftwood: 'progreso,' 'proceso,' 'modernizacion', 'necesidades,' 'comunicacion,' 'informacion,' 'crisis,' 'desarollo.'" (Poersken 2004, p. 1). Though masked by another tongue, these words stay the same as they shift from language to language. After all, Poersken's text itself is translated from German. Plastic words therefore offer a unique challenge to the concept of semiotics. They have a vague evocative meaning which is different from the types of words which are set to function within a system of meaning, of language and its culture. They are symbols which can signify anything.

Our Scientific Language

> Knowledge is, by its nature, always incomplete. 'A scientist is never certain,' the scientists Richard Feynman reminds us. And neither, the poet John Keats would argue, is a poet.
>
> – Eula Biss

Science is engaged with a pursuit of truth. This is fundamentally different than saying science can tell you the truth. Scientific discoveries are better understood as constructs rather than theories, and bear the imprint of culture in which they were made. Science itself is a culture, one among many. If we are to accept the OED definition of culture which suggests that culture is "The cultivation or development of the mind,

faculties, manners, etc.; improvement by education and training" or "The devoting of attention to or the study of a subject or pursuit", or even "The distinctive ideas, customs, social behaviour, products, or way of life of a particular nation, society, people, or period" and "The philosophy, practices, and attitudes of an institution, business, or other organization", ("culture, n", 2018) we can see how the practice and study of the sciences fits neatly within these definitions. Cultures shift, change and morph. They are not comprehensive nor universal. Often scientific findings, and the policies based upon these findings are taken literally enough to reflect honestly natural law. Sometimes this is relatively harmless and aids in our continually adapted understanding of our universe. Yet historically, scientific findings and policies based upon them have been used to perpetuate sexism, racism and oppression which reflects less a natural law and more the cultural biases of the time period. A charged example of this is how the biased study of human skull shapes, called phrenology, was used to assert that Caucasian males were the intellectually superior race and gender of humankind. An effect of the study of phrenology was the belief that non-white people were biologically incapable of adapting to modern industrial societies. These findings conveniently coincided with Andrew Jackson's policy of Indian Removal in 1830, in which the Caucasian settlers of the Americas were legally permitted to relocate the local native peoples from their homes ("Skulls in print", 2018). Scientific understanding of gender too has often mirrored sexist beliefs of the time. Feminist and scientist Donna Haraway remarks how, "Women know very well that knowledge from the natural science has been used in the interests of our domination and not our liberation" (Haraway, 1991, p. 8). She describes how the Committee for Research on Problems of Sex examined differences between the genders

in mental or emotional cognition, happiness in marriage, and other sex-based investigations from 1922 through post World War II (Haraway, 1991). In Charles Darwin's (1809-1882) *Descent of Man and Selection in Relation to Sex* (1889) the idea that women are evolutionarily inferior to men is seminal to his text. He argues that "man has ultimately become superior to woman" (Darwin, 1889, p. 362), not just in physicality and strength, but "Man is more courageous, pugnacious, and energetic than woman, and has a more inventive genius" (Darwin, 1889, p. 356). Sexist and misogynist language has been historically used to describe the pursuit of knowledge through science. In her article "The Scientific Revolution and The Death of Nature", environmentalist and feminist Carolyn Merchant describes how 17th century scientist Francis Bacon (1561-1626**)**, often referred to as the father of empiricism, used this sort of sexually violent language to describe scientific endeavors. Bacon would spoke of Nature as a woman keeping secrets "laid up in the womb" or hidden in her bosom which "a man [ought not] make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his whole object" and would encourage his followers to grab nature by the hair and enslave her (Merchant, p. 521). Bacon metaphorically compares this way of gaining knowledge from Nature to the way in which women suspected of witchcraft were subjected to torture in order to generate a confession. Merchant elaborates and contextualizes Bacon's metaphor and alludes to interrogation and torture of witches as an early tool of the scientific pursuit of knowledge. She writes that James I of England (1566-1626) "believed that witches had powers over people and nature, knew secrets, and could be forced to confess those secrets if interrogated under torture or shown the instruments of torture" (Merchant, 2006, p. 519). The wisdom of women folk healers, midwives and

nurses or "witches" of the 16th century often posed a threat to practicing male physicians in the field of medicine. Historian Clifford D. Conner in his book *A People's History of Science* (2005) notes Bacon remarking that "witches and old women and imposters have had a competition with physicians" (Conners, 2005, p. 369). It is not, then, surprising that the patriarchy of science sought eradication and extrapolation of women's wisdom. As Vandana Shiva, environmental activist writes "Western culture's favourite beliefs mirror in sometimes clear and sometimes distorting ways not the world as it is or as we might want it to be, but the social projects of their historically identifiable creators" (Shiva, 2003, p. 10). In short, there is plenty of evidence to show how scientific knowledge reinforces misleading and harmful ideas of racism, sexism and violence.

Another example of a misleading scientific narrative is in the literature of invasive species management. The idea that certain species are invasive emerged in the United States in a post-war period, and is historically charged with a war language that still lingers today. Scientific constructs are often misleading (as in the case of species waging war) or literally incorrect (as in the case of phrenology). Because the words and beliefs of scientists and/or popular science journalists carry influential power over the public, policies acting in response to these theories can have detrimental effects. My focus is on these effects of misleading, inaccessible language used by scientists, which invariably strengthen the power of science to convince people of its stories. In order to understand where this misleading and inaccessible language comes from, we will look briefly at the beginnings of institutionalized science.

History of Scientific Language

A Language for the Secret Elite

The 17th century enlightenment occurred thanks in part to the burgeoning of certain scientific societies: the Royal Society in England (Gilbert & Stocklmayer, 2012), Rome's Academia dei Lincei, Germany's Academia Naturae Curiorsorum, and France's Academie des Sciences (Daston, 2009). In these early days, scientists met with one another in person to discuss their findings. As science grew as a discipline, scientists would write their findings in published papers. At first, these papers read like modern day tabloids—chronicling miracles like a sky with three suns, or rains of blood (Daston, 2009). Within 200 years of the Royal Society's establishment, scientists created a technical, specialized language to report their findings. These papers were difficult to read or understand for people who were not scientists. There was an aura of mystery around science: scientists were viewed as elite, their discoveries secret and inaccessible. As a literary example, Francis Bacon's (1561-1626) fictional story, *New Atlantis* (1697) contains evidence of this idea that science should be reserved for a select group and its findings kept secret. In *New Atlantis*, Bacon describes a utopian island of vast technological achievements called Bensalem. In Bensalem, the Salomon's House is the name of the secretive school in which a select elite learn to hone their control and mimicry of nature (See Appendix 2). To the public, the purpose of Salomon's House: "is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible" (Bacon, 1697, p. 71), but their findings and abilities are kept well-guarded and secret, known only to a few. There is a note to the reader in *New Atlantis* in which Bacon's secretary writes that Bacon wanted the secretive elitist Salomon's House to be a practical model for existing and future schools designed to deepen scientific knowledge in the late 17th century. We can refer

back to the pseudo-science of phrenology for a nonfictional example of how elitism, in this case compounded by racist ideology, was constitutive to the development of science. The key phrenological text *Crania Americana*, written by Samuel George Morton, which asserts that Caucasians were an intellectually superior race, was expensive. Copies were only available to the richest institutions. This text, which rationalized racialized hierarchies, was widely read among the educated elite, but the majority of people were exposed only to the racist and violent effects of this ideology ("Skulls in print", 2018). There were those who argued against this inaccessibility, and fought for scientific knowledge and information to be disseminated democratically. During the scientific revolution of the mid-17th century, various groups opposed monopolized scientific knowledge that was reserved and censored in academic spheres—like Royal College of Physicians, which strategically withheld medical information—in favor of "ending the distinction between specialists and laymen" and forming a "new, democratic system" (as cited in Conners, 2005, p. 358, 359). During this revolutionary time, Gerard Winstanley (ca. 1609-after 1660), leader of a group called the Diggers "wanted science, philosophy and politics to be taught in every parish by an elected non-specialist" and that "knowledge and education should not be monopolized by scholars in elite universities" (as cited in Conners, 2005, p. 359), but after the revolution, the sort of language used to describe science remained technical and dissemination of knowledge and information remained undemocratic and a conservative elite Baconian science prospered (Gilbert & Stocklmayer, 2012). While technicality of this sort of language may be inevitable, an undemocratic censored or inaccessible mode of information release is not.

A Dead Language

Latin was the original language of science. Botanist Carl Linnaeus (1707-1778) is widely known for carving up the world he observed around him using Binomial Nomenclature, which gave animals and plants specific Latin names. Scientists also published in Latin. At a glance, this use of Latin appears to be a way to write about science objectively. Latin was a dead language. There was no one and no culture alive to claim Latin. The use of Latin too could be seen as a way of making science more democratic. Because Latin belonged to no one, it could theoretically belong to everyone equally. However, this only makes sense if Latin were understood equally by everyone, yet Latin was only taught in colleges and schools, meaning that the uneducated masses would not be able to understand it. There is historical evidence that Latin was intentionally used to elevate its subjects. For example, Giambattista Dealla Porta, who created one of the earlier and more experimental institutions of science in the 1560s, "wrote in Latin, and not for the people" (as cited in Conners, 2005, p. 353). For others, Latin "was the esoteric language used to prevent the dissemination of learning to people who were deemed unworthy of it, or who might make a bad use of it" (as cited in Conners, 2005, p. 306). Among many of the scientific elite, there was distrust of uneducated people, and a desire to keep them from being able to know science. Francis Bacon may have insisted that the study of science was to better mankind, yet his agenda would also appear to have included using science to reinforce the dominance and power of elites. He is quoted as saying "I do not like the word People" who he regarded as "the commonality" or "the meaner sort" (Conners, 2005, p. 362). This notion is reflected in Bensalem's societal power dynamics in *New Atlantis*. Bacon, among other scientific revolutionaries of this time, wrote in both Latin and the vernacular, which appears like a

step towards a more democratic science. However, the publications they wrote in were designed for the educated and an urban middle class which together would form a powerful dominant elite as the early days of capitalism favored and rewarded these classes of people with wealth and power over an uneducated working class (Conners, 2005).

Distrust of Language

Scientists wanted to relay revelations of nature in a precise, unbiased way. This resulted in a general distrust of *language itself* by scientists. In their essay, "The Image of Objectivity" (1992), science historians Lorraine Daston and Peter Galison quote a late 19th century physiologist describing how and why language does not mix well with science: "Born before science, language is often inappropriate to express exact measures or definite relations" (Daston & Galison, 1992, p. 81). In his essay "Science Versus Literature", Roland Barthes explains:

> As far as science is concerned, language is simply an instrument, which it profits it to make as transparent and neutral as possible; it is subordinate to the matter of science (workings, hypotheses, results) which, so it is said, exists outside language and precedes it. On the one hand and first there is the content of the scientific message, which is everything, on the other hand and next, the verbal form responsible for expressing that content, which is nothing (Barthes, 1997, p. 94).

An indeterminate and often misunderstood phenomena, language cannot pronounce the exactness that an appropriate revelation of nature seems to require. Language can be loaded and laden with many meanings and thus open to interpretation. In order to transcend language, scientists cultivated objectivity, which was structured by the scientific method, graphs and charts, and by what was considered proof or evidence.

This objectivity relied heavily on the new technology of photography to render nature precisely, without the messy middleman of language. In this way, it was thought, nature might be better able to speak for itself. Objectivity in science was considered honest, but also relied upon and entailed morality: Daston and Galison explain that it was considered a scientist's *moral duty* to do their utmost to identify and set aside their bias, expectations, and emotions in favor of a more mechanical way of representing nature. Language betrayed humanity, and so scientists trusted photography and related technologies, not to *tell* but *show* nature's truth (Daston & Galison, 1992). The assumption, now disproven, was that subjectivity does not and should not affect scientific findings and agendas.

Latin American fantastic fiction writer, Jorge Luis Borges, writes satirically about this desire for precision and accuracy in scientific study in his short story, *On Exactitude in Science*:

> …In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that the vast Map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography (Borges, 2002, p. 12).

Borges describes here what happens when the map literally becomes the territory, when it is used to represent that which it describes on a one-to-one scale. This playful thought experiment satirizes the impracticability—and nonsense—of an exact correspondence

between signified and signifier. There is always slippage. Here is a modern equivalent of Borges' cartographers in a description of what satellite images can and cannot relay:

> Satellite pictures scanning the globe's vegetative cover, computer graphs running interacting curves through time, threshold levels held up as worldwide norms are the language of global ecology. It constructs a reality that contains mountains of data, but no people. The data do not explain why Tuaregs are driven to exhaust their water-holes, or what makes Germans so obsessed with high speed on freeways; they do not point out who owns the timber shipped from the Amazon or which industry flourishes because of a polluted Mediterranean Sea; and they are mute about the significance of forest trees for Indian tribals or what water means in an Arab country. In short, they provide a knowledge that is faceless and placeless, an abstraction that carries a considerable cost: it consigns the realities of culture, power and virtue to oblivion. It offers data, but no context; it shows diagrams, but no actors; it gives calculations, but no notions of morality; it seeks stability, but disregards beauty (Sachs, 1999, p. 44).

Borges' cartographers' mapping technique provides an accurate representation of the landscape on a scale of 1:1, but it's only 2-dimensional, lacking in depth, erasing and occluding facts that don't fit with their measurements. In their attempt to be perfectly objective, the cartographers fail to be empirical.

Not only is objectivity impossible, but the objective is always provisional; a model that can show only partial perspective. In 19th century science, the attempt to be objective results in the valorization of photography and detailed drawings. Of those who employed these photographs and detailed depictions, Daston and Galison write they did not "regard the aesthetic with suspicion, as being opposed to scientific accuracy" rather, they "considered the beauty of depiction to be part and parcel of achieving that accuracy, not a seduction to betray it" (Daston & Galison, 1992, p. 14). These techniques were aesthetic, as much as the "flowers of language" (Daston a& Galison, 1992, p. 14) which objectivists bemoan. What Daston and Galison show is that as well as being by degrees

more objective methods of representation, these techniques to describe nature are truly *stylistic* preferences. We can sense an example of this when we consider science's preference of passive voice. As author JM Coetze explores in his essay "Newton and the Ideal of a Transparent Scientific Language" (1956), passive voice is nothing but a stylistic mode by which truly subjective views come across as objective, given, natural and eternal. Rather than the rather human "*I* observed a certain natural phenomenon" we have "A certain natural phenomenon was observed". In the second sentence, it is implied that anyone, anything, even God themselves could have observed the natural phenomenon. Philosopher Immanuel Kant (1724-1804) explores the way by which bias inherently cloaks our understanding of the world. According to Kant, our mind organizes the world around us, from mystery and chaos into something orderly and familiar. But this organization differs from person to person, mind to mind. Therefore, the true world is likely not as we see it or understand it, and each of us sees the world differently from one another. Ultimately, the objective world exists beyond, and without, our inherently subjective minds (Velasquez, 2017).

The Effect of Objectivity on Language

What are the effects of a scientific technical language born out of this desire for objectivity? A diffusion of science's inhumane objectivity into language itself. Richard Stivers, in his book *Technology as Magic* (2006) describes how science builds its vocabulary. He writes how lexicographers have found science and technology to be responsible for nearly half of the new words added to the English language in the 20th century, and writes of a study conducted by Raymond Gozzi which reveals that 45% of

the words created between 1960 and 1985 were created on behalf of science and technology (Stivers, 2006). Uwe Poersken writes that "a scientist is fundamentally the master of his language" (Poersken, 2004, p. 43). The scientist explores and occasionally creates concepts and so has to name them. The scientist uses symbols or phrases whose purpose is to suggest something "briefly and unambiguously" (Poersken, 2004, p. 43) without being applicable to other concepts. The scientist therefore enjoys a language made for exactly this purpose, a language that is not *common*. Science and the common vernacular are kept separate. In her book, *The Human Condition* (1958), German philosopher Hannah Arendt (1906-1975) addresses what it means for science and language to remain unmixed, for logic and reason to leave behind the poetic, human, familiar and relatable. She notes that "the 'truths' of the modern scientific worldview" can be "demonstrated in mathematical formulas and proved technologically" (Arendt, 2012, p. 3), but will not be understood in normal language. She says that "the sciences today have been forced to adopt a 'language' of mathematical symbols" (Arendt, 2012, p. 3), originally meant as abbreviations or placeholders for common language, but now can be strung together to form "sentences" that cannot be translated back into any vernacular. The sciences have developed highly technical, specialized language. Arendt is concerned about the political implications when ordinary people are unable to talk or think about what science lets us do, requiring "artificial machines to do our thinking and speaking" (Arendt, 2012, p. 3). In the end, because we are so often prompted to adopt the ways and rites of science into our daily lives, "we would in all earnest adopt a way of life in which speech is no longer meaningful" (Arendt, 2012, p. 3). Speech and the rules of grammar become less important in the pursuit of the rules of nature, and clarity is sacrificed.

Scientific Language Today

Scientists learn the technical language of their discipline (Rakedzon, Segev, Chapnik, Yosef, & Baram-Tsabari, 2017; Sharon, Baram-Tsabari, 2014) without understanding rhetoric—the idea that writing and *language itself* is a social act, involving readers and standards for clarity (Rakedzon et al., 2017). There is another bias that emerges when describing or relaying scientific findings, called the "curse of knowledge" which suggests that people forget that they did not have the knowledge they do now (Rakedzon et al., 2017; Sharon et al., 2014). This "curse" makes it difficult to recognize the importance of clarity in writing. It makes it difficult for scientists to empathize with their audience or to consider what their audience may or may not know or understand. There are two specific types of abstraction I will focus on in this thesis: scientific jargon and plastic words. While the data collection and analysis focus on plastic words, I feel it's important to include scientific jargon, to compare characteristics.

Scientific Jargon

There is a name for the mechanical language Arendt and Poersekn describe, the language scientists invent when they invent new concepts and need to name them something that lies beyond common day-to-day language. Scientific jargon is the highly specialized or technical terminology used in specific disciplines. In the OED, jargon is defined as “Unintelligible or meaningless talk or writing; nonsense, gibberish. (Often a term of contempt for something the speaker does not understand)” and “A conventional method of writing or conversing by means of symbols otherwise meaningless; a cipher, or other system of characters or signs having an arbitrary meaning” and ”Applied contemptuously to any mode of speech abounding in unfamiliar terms, or peculiar to a particular set of persons, as the language of scholars or philosophers, the terminology of a science or art, or the cant of a class, sect, trade, or profession” (“jargon, n”, 2018).

Effects

Specialized terminology suggests professionalism. When scientists discover new scientific findings, they create words to describe these findings, new highly specific words that will not be used by everyone but almost entirely only by those in the specific discipline in which the word was born. Use of jargon helps condense otherwise wordy explanations. In specialized disciplines, use of that specialized jargon is effective in communicating new findings (Rosenberg, 2012). For example, acronyms used for shorthand, or fewer words to describe more complex phenomena that require lengthier explanation, as can be discerned from the following example. In a sentence containing scientific jargon, one could describe a certain cellular activity in this way: “The phospholipid bilayer allows for bidirectional transport of cellular metabolites via

membrane pores and transmembrane proteins" (Rosenberg, 2012, p. 2). A second sentence containing no scientific jargon explains the same activity this way: "The cell membrane allows for the entry of molecules needed by the cell as well as the exit of molecules produced by the cell. Depending on the molecule, it will either pass through small holes in the membrane called pores or through proteins embedded in the membrane" (Rosenberg, 2012, p. 2). The difference of comprehension between the two sentences is clear. Anyone who is not a specialist in cell membrane activity will be able to understand the second sentence with more ease than the first.

However, outside of specialized disciplines, for the general public, this jargon confuses. It distracts. It complicates and frustrates. It makes new discoveries in science largely inaccessible because readers cannot grasp concepts when they are several layers removed—abstracted—from their original context. Concepts are rendered in familiar and idiosyncratic grammar and syntax becoming in effect a foreign language, unreadable and unspeakable by those for whom the language nonetheless bears upon. This creates a form of illiteracy that forecloses politically consequential engagement with scientific problems on the part of the public.

Such barriers to understanding are measurable. It is estimated that in general academic texts, there is 5% jargon, 80% high frequency or commonly used familiar words and somewhere between 8-10% academic vocabulary. In *scientific* academic texts, jargon is around 22%. According to a study by Marcella Hu Hsuech-Chao and Paul Nation (2000), accurate comprehension of a document requires 98% familiarity with the vocabulary. In a study on read-difficulty and comprehension among non-native adult

readers, minimum comprehension required 95% familiarity with vocabulary (Rakedzon et al., 2017). When the Flesch Reading Ease (FRE) test—which measures a text's readability from 0 (unreadable) to 100 (understandable)—was applied to 'Summaries for Policymakers' from The Intergovernmental Panel on Climate Change (IPCC), the document scored below 20. The results of the study suggested not many people would be able to make sense of IPCC texts. The IPCC monitors research in global climate change with the charge of widely disseminating its findings, a task complicated by the fact that their readability score is low and therefore difficult to understand (Barkemeyer, 2016).

There are methods and models, tools and tricks that exist to help scientists write in clearer ways. Being aware of effects of jargon and the importance of clear writing can help. Keeping the audience in mind is another way to keep from slipping into specialized language without clarification. There is even a software program called *Automatic Jargon Identifier*, which scientists can use to scan their documents and to make their writings more accessible and transparent to the public (Rakedzon et al., 2017).

Scientific jargon contributes to inaccessible scientific writing, but it can also diminish the scientist's ability to communicate appropriately with other people. There are times when this gap in understanding can result in real human consequences.

For example, when genetic counselors discuss with pregnant women the risks their unborn children may pose, there is a tangible, if not "provable" dissonance between the words and concepts that need to be relayed to the pregnant woman and her own understanding of her baby. Silya Samerski describes this effect in the word "gene" in the context of genetic counseling. She writes: "On the one hand, 'gene' demands significance, meaning. On the other hand, it cannot signify anything outside the lab. This

paradox enables the ’gene’ to work as a bridge between statistics and real life” (Samerski, 2002, p. 3). She goes on to relay a scene in which a genetic counselor seeks to advise a pregnant woman:

> 1. The geneticist talks to a laywoman. He has to spell out his knowledge in such a way that normal people can follow him. To do so, he has to find everyday words for notions like chromosomal aberration, DNA-mutation and probability model. 2. Once talked to, the client is urged to make a decision. This decision is, in some way, a decision about life and death, about delivering a child or terminating a pregnancy. Facing the counselor’s genetic mumbo jumbo the client inevitably asks herself: What does all this say about me? What does all this mean to me? Genetic counseling is a glaring example of the clash between scientific concepts and everyday meaning (Samerski, 2002, p. 6).

We can see here how the objective word “gene”, when used in this sort of delicate situation that would greatly benefit from sensitivity to and skillfulness in translating between specialized jargon and the ordinary vernaculars of lay people, aggravates confusion, dissonance and distance between pregnant woman and genetic counselor. Intentional, objective abstraction from human emotion and bias carried into this sort of situation is emotionally harmful. To the would-be mother, her own child has been transformed before her very eyes into a potentially dangerous risk.

Scientific jargon isn’t itself necessarily problematic. In fact, it is an unavoidable language. It is necessary to create new words as new concepts are created, and natural phenomena discovered. Creating new words, too, is a fundamental component of language that keeps it alive and relevant as our values, beliefs and ways of communicating with one another and within the world around us shift and change. However, the abstracting inhuman way of relaying certain scientific jargon is startling, as

we can see in the gene episode above. This episode is so startling because of the power that the scientific jargon term ‘gene’ has.

Our Culture and Science Communication Today

Our culture today largely valorizes science. Science can be almost impossible to challenge. Science has enabled policies that have direct effects upon our ways of living and knowing. Historically, phrenology provides an example of the harms done when ideology masked as science underlies policy-making. As long as science shapes policy and social thought, there is a dire need for its language to be more accessible, otherwise the general population is subjected to policies, rules and regulations which they cannot understand or challenge.

On the other hand, there is one form of science which is noticeably and arrogantly being ignored today. We are in the midst of a climate crisis, exacerbated by an ideologically-driven denial of climate change. The current president of the United States of America, Donald J. Trump, is using his power to roll back policies and regulations put into place to curb causes and aggravators of global warming (MacMillan, 2017). This denial and widespread mistrust of science and the educated elite seems to this author a rebellion against historical science’s mistrust of non-scientists and uneducated mass thanks largely to leading figures during the scientific revolutionary period, like Francis Bacon. This pivotal argument seems to this author to be a symptom of undemocratic communication within and around science today. Rather than an utter rejection of science, Trump uses the selfsame words of power, plastic words, to promote his own alternate narrative against the scientific agenda. In his speech in which he withdraws the United States of America from the Paris Climate Accord, he argues that the Paris Climate

Accord diminishes *production*, and reduces *development*[1] (Trump, 2017). For this author, it is not the message carried that bears complaint, but the way by which the message is carried. Uwe Poersken writes, "these opaque vocabularies above all shout 'science!'" (Poersken, 2004, p.75). The words Trump uses are, ironically, cloaked in the very same sort of scientism he argues against. With these words, even the weakest argument can gain momentum and power.

Therefore, this author would suggest a fundamental rethinking of science's place in culture. I believe that to humble science is to elevate it. It is important not just to admit, but to emphasize that this worldview of understanding nature and reality rests on a certain amount of uncertainty. Further, we see science as something that gives us gifts, makes our lives easier, tells us how to live longer, better, shows us how to do things faster, unveils hidden mysteries of the earth, the universe, the multiverse. At the center of this powerful discipline is the fact that we cannot speak within it. To have an unchallengeable discipline at the core of a democratic society is hypocritical; it is not a true democracy. Some may argue that it is the job of popular science journalists, and not scientists, to translate scientific findings to the public. Writers such as Malcolm Gladwell, Atul Gawande, Michael Pollan, and others take more complex scientific issues and rearrange them into manageable, simplified, energized pieces for non-scientists to consume with more ease. The problem with this "translation" is that it is not a translation of information, but an oversimplification of complex issues. Whether or not this simplification is intentional, these popular science journalists are making people believe

[1] Production and Development are plastic words. For a full list of Uwe Poersken's plastic words, see page 46.

they understand something completely which they may actually not understand. For example, a New Yorker article by Kathryn Shulz came out in March of 2018 describing the noxious invasion of stink bugs. The article vividly and stylistically paints these creatures as swarming entities straight out of a horror film. Many letters to the editor praise the author's rambunctious tone, writing "I simply could not tear myself away. That she was able to lure me in and keep me reading to the very end is proof of her spell-weaving ability" (Horowitz, 2018) or "What a disgusting story, brilliantly written: Stephen King meets Rachel Carson" (Walter-Toews, 2018). Yet one reader shared this insight:

> As Mark Twain noted, 'Nature knows no indecencies; man invents them.' Schulz relies on the same highly militarized and villainizing language that's widely used to describe other so-called invasive species. These critters have arrived in their new homes not of their own agency but through careless (and sometimes intentional) handling by humans. Our breathtaking sense of exceptionalism insures that our errant ways in bringing pests from elsewhere is never our fault but somehow that of the organisms themselves. They are blamed for doing what all organisms do—attempt to reproduce and survive. As loathsome as they might smell, act, or be, they are not the villains in these environmental dislocations; we are (Lewis, 2018).

Popular science here perpetuates a misleading and biased story about invasive species, easily and eagerly consumed by a public, save for one careful reader. This popular science glorification and romanticism of a phenomena in turn tends to encourage people to very highly regard a discipline they do not understand, but one that has control over the way they see themselves, each other and the world around them. When dealing with science, which has a vast magnitude of power, we must ask if this simplification, through use of metaphor and other devices, is it a service or a manipulation?

Today we live in what is colloquially called “The Information Age”, which suggests that we have easy access to information. True, “information” can be accessed with near instantaneous speed almost anywhere in the world. This access has the potential to make scientific findings reach more people. While the public can easily access scientific findings, they may not have equal access to *understanding* what these findings mean (Barkemeyer, 2016). I argue that it is necessary to promote the clarity and readability of scientific texts and that it is possible to do so without compromising professionalism or abandoning necessary jargon and terms of art.

Metaphors

> The price of metaphor is eternal vigilance.
>
> – David Cayley

We have already examined the OED definition of metaphors, but let’s unpack and probe them further. Metaphors marry two different ideas between two different realms into one notion. Metaphors are a sort of linguistic alchemy, turning one thing into something completely different. Where a simile will say one thing is *like* another, metaphor will say one thing *is* the other. An example is ‘Juliet is like the sun’ vs ‘Juliet is the sun’. In poetry, literature, or drama, the use of metaphors tends to be stylistic; invoking aesthetic elements of natural world that stir emotion (Phillips, 2017). In Shakespeare’s *Romeo and Juliet*, Romeo compares Juliet to the Sun using a metaphor: “But soft, what light through yonder window breaks?/ It is the east and Juliet is the sun” (Shakespeare, 1965, p. 36). Metaphors are effective tools of persuasion, because they invoke emotion from something familiar or universal, like the brilliant sun, into the something they want the audience to understand, like Romeo’s perception of his love

Juliet (Phillips, 2017). They can help an audience to empathize, which is to feel the emotion of another (fictional or otherwise).

In the arts—literature, drama, poetry, the persuasive use of metaphor is essentially a harmless, stylistic element that serves to illustrate and generate empathy and beauty. When used in disciplines of power, like policy, government, and science, however, this persuasive rhetorical tool can be controlling, suggestive and manipulative. As Colin Koopman describes in his article "The Algorithm and the Watchtower" (2015):

> To make sense of the new political power that can be built out of all this data requires metaphors, and these metaphors themselves are not without political stakes. Metaphors help shape the meanings of the activities in which we are engaged and they thereby help condition what possible actions we can conceive ourselves as undertaking. Metaphors thus have a political stake in that they define the forms of power that control us and the forms of possible resistance to power we can imagine (Koopan, 2015).

Metaphor, then, can become a tool of propaganda in the hands (or mouths) of the powerful. Some metaphors are obvious, such as "time is money." Even though this is clearly a bit of poetry, it nevertheless governs how we think about time. The danger of metaphor is when they are subtler and when we forget their literary foundation. Non-fiction writer Eula Biss writes about anthropologist Emily Martin who asked a group of scientists about the reliance on war metaphor to describe the body's immune system. Some disagreed that it was a metaphor. They replied that that was just "how it is" (Biss, 2011, p. 56). The linguistic alchemy is thorough, and somewhere down the line as we spray poison across our lawns, we might really believe that a dandelion is an invading enemy.

Figure 2 Soldiers Marching

Figure 3 Marching for Pesticides

Why are Metaphors used in Science?

In *Metaphors We Live By* (1980), George Lakoff and Mark Johnson describe various metaphors that have slipped into vernacular and become unnoticed. For instance, Lakoff and Johnson describe the generically adopted idea that argument is war by calling to mind various phrases that refer to arguments but invoke militaristic metaphors. Examples include:

> "Your claims are *indefensible*.
> He *attacked every weak point* in my argument.
> His criticisms were *right on target*.
> I *demolished* his argument.
> I've never *won* an argument with him.
> You disagree? Okay, *shoot*"
> If you use that *strategy*, he'll *wipe you out.*
> He *shot down* all of my arguments" (Lakoff & Johnson, 2011, p. 4).

Science is no exception; Alan Gross, in his text *Rhetoric of Science* (1996) writes "Science is full of metaphor, and it is the nature of metaphor deliberately to misname" (Gross, 1996, p. 80). This phrasing implies intentional manipulation, but metaphors are so often used in science specifically because they make more complex concepts easier to understand. Conveying these abstract scientific findings in a clear comprehensive way often requires metaphor.

Some Common Science Metaphors

Scientist Richard Lewontin describes a metaphor called "the billiard ball model of molecules" (Lewontin, 2009, p. 238) which is used in physics to explain how molecules bump into and rebound off of each other—like billiard balls. This metaphor, he argues, is harmless because we use the idea of billiards to make sense of molecular behavior but we don't imagine that molecules *are* billiards—colored balls with numbers on them. In

contrast, there are trickier metaphors (Lewontin, 2009). For example, health and medicine rely on militaristic metaphors: germs *invade* the body, the patient *fights* or *combats* illness. Likewise, invasive species management relies on a similar metaphor of militarism and war. These militant metaphors are easy to swallow, visible and evocative. American writer Susan Sontag explores why misuse of militant metaphors tend to lean towards propagandist agendas. She writes:

> Indeed, the transformation of war-making into an occasion for mass ideological mobilization has made the notion of war useful as a metaphor for all sorts of ameliorative campaigns whose goals are cast as the defeat of an 'enemy'…Abuse of the military metaphor may be inevitable in a capitalist society, a society that increasingly restricts the scope and credibility of appeals to ethical principle, in which it is thought foolish not to subject one's actions to the calculus of self-interest and profitability. War-making is one of the few activities that people are not supposed to view 'realistically'; that is, with an eye to expense and practical outcome. In all-out war, expenditure is all-out, unprudent—war being defined as an emergency in which no sacrifice is excessive (Sontag, 1989, p. 99).

Sontag here unites capitalism and war to explain why militant metaphors are especially successful in shaping our perceptions and responses. It is because they feed off a common self-serving, and as Sontag suggests unethical predisposition which, she argues, we can attribute to capitalist society. Capitalism praises self-centered survival above all else, and in war it is every man for himself. Her quote suggests that, in capitalist society, we are waging war with everyone else, because they are not us. Poet Franco "Bifo" Berardi similarly suggests: "Only an act of language escaping the technical automatisms of financial capitalism will make possible the emergence of a new life form" (Berardi, 2011, p. 157). So it is not necessarily metaphors of militarism and war, but ultimately modes of thought associated with capitalism that may be the true enemy, starving out alternate perspectives.

Figure 4 Kill Capitalism Not Weeds Graffiti

In a slightly different vein, let us see what happens when wheat becomes a *product* and soil becomes a *resource*. As economic terms are applied to natural phenomena our understanding of the world is changed. Agriculture employs economic metaphors to maintain a capitalist and monetary perspective of the land. Economic metaphors are rampant in agriculture, and it is because land today has become a commodity. Food costs money, and so food has *become* money. The economic/agricultural terminology exchange goes both ways—we refer to stocks or money *growing* in our bank accounts. In each of these cases, from medicine to the stock market, we have ceased to recognize the operation of metaphor. How else can you describe what money does when it's in a stock? Of course wheat is a product, what else could it be? But once upon a time, wheat was nothing more than a gold-yellow plant growing from the ground rippling pleasantly in the wind, looking stunning in sun against the backdrop of blue sky. Now wheat is a *product* grown out of a *resource*, or even: now wheat is money grown out of money. First food was grown and eaten. Food was food. Then it was sold for money and now it is money. This is the great linguistic alchemy of metaphor: money doesn't grow on trees because, well, *trees are money*. These sorts of metaphors are familiar and cozy. They fit snuggly into place. In these cases, "it's easy to forget that metaphors are metaphors, that they are provisional and limited comparisons, not literal descriptions" (Lewtonin, 2009, p. 238). These metaphors are strong because of the scientific sounding words in them, but when we forget that they are metaphors we regrettably think we know they are fact.

In an interview with writer David Cayley, Richard Lewontin describes the problem with uniting previously unrelated theories across disciplines. He explores

bringing the idea of evolution into different disciplines or arenas, for example, considering how human societies change over time as evolution. This bridging of ideas makes it easy to understand an interpretation of this history, but it is still only an *interpretation*. It is easy to understand because it uses the concept of evolution—which is well known. However, it is essentially inaccurate, because human societies change in ways that are fundamentally different from Darwin's theory of evolution. Evolution suggests a step-by-step increasing complexity. Societies, however, do not evolve in the way that an animal does—in lay terms, by becoming better adapted (Lewtonin, 2009). As ancient Greek philosopher Aristotle (384-322 BC) warns us in *Rhetoric* (350 BC); "in using metaphors to give names to nameless things, we must draw them not from remote but from kindred and similar things, so that the kinship is clearly perceived as soon as the words are said" (Aristotle, 350 BC, p. 4). There's always been a danger in stretching the bridge of metaphor too far. We need only glance at the unsustainable way most people live now compared to how people used to live as proof enough that societies do not necessarily change or *evolve* for the better, if at all.

Of course—not to dwell on the obvious—language itself is metaphor. Words are not the things they describe. When calling a chair a chair, we are calling a unique, one of a kind object a name that many other distinct objects are called. The thing which I am currently sitting on right now is not a chair. Chair is just a name we have invented to exchange the idea of chair with one another. My name is Clare, but Clare is not *what* I am. To borrow once again from William Shakesepare's (1564-1616**)** *Romeo and Juliet* (1492):

> Tis but thy name that is my enemy./ Thou art thyeself, though not a Montague./ What's Montague? It is not hand, nor foot,/ Nor arm, nor face, nor any other part/ Belonging to a man. O, be some other name!/ What's in a name? That which we call a rose/ By any other word would smell as sweet./ So Romeo would, were he not Romeo called… (Shakespeare, 1965, p. 37).

Strange that a passage from Shakespeare would provide a strong caution about the power of language to seduce and persuade. Scientists and Shakespeare both toil in the world of metaphor, a medium of linguistic exchange where nothing is innocent.

Authors Derrick Jensen and George Draffen, in their book, *Welcome to the Machine: Science, Surveillance, and the Culture of Control* (2004) explore the etymology of science. Science comes from the Latin *scientia* and *sciens*, which mean having knowledge. The present participle of this Latin word is *scire* which means *to know*. *Scire* relates to the Sanskrit word *Chyati* which means cuts off. If we bring this word back into Latin, we get *scindere* which means to split or cleave. In Greek, that word is *schizein*, to split. *Schizein* is the root for the psychological disorder *schizophrenia* meaning split mind. The characteristics of schizophrenia are: "a loss of contact with the environment, illogical patterns of thinking and acting, delusions and hallucinations, and a noticeable deterioration in the level of functioning in everyday life" (Jensen & Draffen, 2004, p. 25). This etymology shows a linguistic parallel between the action of splitting that is at the root of the term 'schizophrenia' and the effects of the kind of inaccessible and abstract language used in science, split off from the vernacular. Both are abstract, cut away from the everyday. Both terms indicate a splitting. "Science, scire, scindere, schizein, schizophrenia. A mind split into pieces" (Jensen & Draffen, 2004, p. 25). Without ascribing mental illness to scientists, it's possible to see similarities between science and

this specific psychosis, as both remove the seeing from seer. They are an abstraction from the world. This, regrettably, is the end goal in the pursuit for objectivity.

Plastic Words

In 2004, Uwe Poersken wrote a book called *Plastic Words: The Tyranny of a Modular Language* (2004) which discusses 'plastic words', named by Poersken for their malleability. Plastic words stem from the vernacular, migrate into scientific discourse, and then return to the vernacular. In this migration, meaning is lost (Poersken, 2004). Here are Uwe Poersken's plastic words:

accomplishment
basic needs
capitalization
care
center
communication
consumption
contact
decision
development
education
energy
exchange
factor
function
future
growth
health
identity
information
living standard
management
modernization
model
partner
planning
problem
process
production

productivity
progress
project
quality
raw material
relationship
resource
role
service
sexuality
solution
strategy
structure
substance
system
value
work
workplace
(Poersken, 2004, p. 62).

Poersken's plastic words are imprecise and vague, often interchangeable. For example, "communication" can be used to describe many different things: a person talking to another person, a cat meowing to and interacting with another animal, a smartphone receiving data from a satellite, etc. More specifically descriptive and contextualized terms, like *talk*, *meow*, or *transmitting data* are eschewed in favor of a generalizing, less communicative term: "communication".

In the final pages of his book, Poersken includes a list that chronicles the 30 characteristics of plastic words. These characteristics show the ways in which plastic words simplify, reduce, and homogenize language decreasing its precision and contextual efficacy.

These characteristics are well worth chewing over, savoring, drinking deeply. You will find the taste of them familiar. For this thesis I focus on a few specific characteristics

of plastic words. They are in bold and then further elaborated upon below (See Appendix 1 for complete list).

1. The speaker lacks the power to define the word.
2. **The word is superficially related to scientific terms. It is a stereotype.**
3. **It has its origin in science.**
4. **It is carried over from one sphere into another, and is in that sense a metaphor.**
5. **It forms an unnoticed link between science and the everyday.**
6. **It has a very broad application (lit. domain of use).**
7. **It displaces synonyms.**
8. **It replaces the conventional, precise word.**
9. It replaces an indirect way of speaking or a silence.
10. **It condenses a huge field of experience in one expression.**
11. It is impoverished in content.
12. Its imagery is vapid and diffuse.
13. It is historically disembedded.
14. It transforms history into a laboratory.
15. It dispenses with the question of value.
16. **The 'aura' and associations of the word dominate.**
17. It names a property and contains the appearance of an insight.
18. **It has more of a function than a content.**
19. As a scientific 'idealization' of something limitless it uncovers and awakens needs.
20. **Its 'naturalness' strengthens this pull.**
21. The resonance of the word is imperative.
22. It has multiple uses.
23. **Its use increases prestige.**
24. **It leads to silence.**
25. **It anchors the need for expert help in the vernacular and serves as a resource.**
26. It forms new words and is a flexible instrument in the hands of experts.
27. **It makes previous words look out-of-date.**
28. In this sense it is new.
29. It is an element of an international code
30. **It lacks an intonation and cannot be replaced by pantomime or gesture**
31. The speaker lacks the power to define the word.
32. **The word is superficially related to scientific terms. It is a stereotype.**
33. **It has its origin in science.**
34. **It is carried over from one sphere into another, and is in that sense a metaphor.**
35. **It forms an unnoticed link between science and the everyday.**
36. **It has a very broad application (lit. domain of use).**
37. **It displaces synonyms.**

38. It replaces the conventional, precise word.
39. It replaces an indirect way of speaking or a silence.
40. It condenses a huge field of experience in one expression.
41. It is impoverished in content.
42. Its imagery is vapid and diffuse.
43. It is historically disembedded.
44. It transforms history into a laboratory.
45. It dispenses with the question of value.
46. The 'aura' and associations of the word dominate.
47. It names a property and contains the appearance of an insight.
48. It has more of a function than a content.
49. As a scientific 'idealization' of something limitless it uncovers and awakens needs.
50. Its 'naturalness' strengthens this pull.
51. The resonance of the word is imperative.
52. It has multiple uses.
53. Its use increases prestige.
54. It leads to silence.
55. It anchors the need for expert help in the vernacular and serves as a resource.
56. It forms new words and is a flexible instrument in the hands of experts.
57. It makes previous words look out-of-date.
58. In this sense it is new.
59. It is an element of an international code
60. It lacks an intonation and cannot be replaced by pantomime or gesture (emphasis mine, Poersekn, 2004, p. 22-23)

Plastic words are the siblings of scientific jargon, but quite removed. They were in the vernacular until adopted by science, and so they carry the weighted power of science, but are in fact weightless in meaning and signification. Because they are so very light, they can be easily carried over to radically different concepts, realms and disciplines, and still promenade a sense of scientific power. Therefore, they neatly bridge the objective world of science with the everyday, but they do so covertly and discreetly, unnoticed. They are single words with countless applications, eradicating or making obsolete their kindred synonym words or phrases. They erase history and context, because they replace more precise and accurate explanation with a solitary empty word—

collapsing vast histories into definitive words. In this collapse, they reject the possibility of alternate historical trajectories, which is for them to say that things as they are could not have happened in any other way. The way the words feel and sound, and the power they radiate are far more important than anything they might mean or suggest. They serve to evoke power rather than to clarify or explain. Because they flow from science into the vernacular, they have the feeling of the scientific, the natural and the believable. Using these words make one seem smart, elite, and powerful. These words generates silence among recipients of the message—they do not offer room for contestation, conversation, disagreement, alternatives. Because they lack meaning, and are simultaneously used by experts or officials to explain, they make it so that one relies upon those experts in power. They differ from the vernacular. While vernacular words similarly can have obscure, difficult-to-grasp meanings, the context surrounding any vernacular word will ground it. Plastic words can be slung repeatedly in a single context, and have varied meanings throughout.

Plastic Words and Scientific Jargon

Their vernacular origins would seem to make plastic words the inverse of scientific jargon, which emerges from scientific language and rarely mingles with the vernacular. Furthermore, terms in scientific jargon retain their meanings consistently in their context, while plastic words are malleable. However, while the they appear dichotomous in these respects, their exclusionary effects are similar. They both abstract and distance. Plastic words and scientific jargon both describe terms that are hard to translate broadly and meaningfully. However, when we hear scientific jargon, we do not presume to understand it (unless we are well oriented in the sub-discipline of that brand

of scientific jargon). Compared to scientific jargon, plastic words are trickier largely because of their widespread use. They hide in plain sight.

Let's unpack the words *developed* and *underdeveloped*. Uwe Poersken and Wolfgang Sachs both describe this story and what it set in motion. Harry Truman, in his inaugural speech, coined the term underdeveloped when referring to certain areas that make up more than half the world. Sachs writes "[f]or the first time, the new world view was announced: all peoples of the earth were to move along the same track and aspire to only one goal—development" (Sachs, 1999, p. 3). This moment served as a global paradigm shift for thinking about how countries work and what they work towards. Poersken unpacks how the rules of grammar are ignored when the word 'development' is used today: "Only the ongoing developments of the fifties gave the teachings of Marx and Engels the place due to them at the University . . . this *process completed itself* on the soil of the German Democratic Republic" (Poersken, 2004 p. 20**).** The word *development* in this sentence is both an active subject doing the developing and the developments themselves. Simply, "Development develops" (Poersken, 2004, p. 20). Under the banner of development, the United States legitimizes invasion and intervention of other countries and cultures under the guise, the euphemism, of *development*. Poersken writes: "With a word such as development, one can ruin an entire region" (Poersken, 2004, p. 7). Development is a plastic word, and it bleeds into other realms. In psychology there are step-by-step levels a parent is supposed to track to ensure that their child achieves the reassuring status of normal child *development*. A fetus develops in similar step-by-step levels. Moreover, building a building of apartment complexes is also considered *development*. This amorphous quality of words comes up in other names. Michel

Foucault describes this as incongruous. Similar to Richard Lewontin's disparage of incongruous metaphors, Foucault argues that uniting certain separate ideas are inappropriate: "word should be taken in its most literal etymological sense; in such a state, things are 'laid', 'place', 'arranged' in sites so very different from one another that it is impossible to find a common place beneath them all" (Foucault, 2004, p. xix).

Plastic Words and Metaphor

The way plastic words are used, Poersken explains, is similar to how metaphors are used. They both carry an idea specific from one domain to another completely different domain (Poersken, 2004). Plastic words share the danger of an overused metaphor conventionally misapplied—

> "the chasm between the sphere of origin and the sphere of application is easily overlooked. There is no tension; no spark jumps between the two spheres. They are tied together seamlessly. Their original separation is hardly remembered. The result: one takes the word for the thing" (Poersken, 2004, p. 76).

As with metaphors when plastic words are used so integrally within a new context, original meaning is lost and we begin to believe in the word as it settles, it becomes familiar to us, and it gains power. Plastic words are adept in many disciplines—they habitat these new domains well, make themselves comfortable and take charge. But most importantly, they do so inconspicuously. It is as if they have always been there, in this other context, sphere, discipline. Poersken mentions that "Our language is quite fragile, has little native resilience" (Poersken, 2004, p. 94). Is it worth noting here that plastic words strike more than a passing metaphorical resemblance to invasive species? Yes, plastic words are kind of how we are made to think about invasive species, as crossing borders or contexts, eradicating other species or words, replacing diversity with

singularity. This chameleon trait and quick ability to adapt, Poersken notes, is why plastic words are "so well suited for colonization" (Poersken, 2004, p. 85).

In a case of plastic word-qua-metaphor, nonfiction author Eula Biss explores the concept of an *immune system* in a series of interviews and reveals another instance in which metaphor and plastic word appear to run together under the banner of science.

> The term immune system… was probably a metaphor from its very introduction. In a medical context, the word system traditionally referred to a collection of organs or tissue, but the immunologists who first adopted it were using it in a broader sense. 'Why was the term immune system accepted so widely and so rapidly?' asks the historian of immunology Anne Marie Moulin. The answer, she suggests, resides in its 'linguistic versatility,' the ability of the term to contain many concepts and multiple understandings. It entered the mainstream just a few years after its introduction to science, spilling into the popular usage of the 1970s. 'Though the term was borrowed from the science of immunology,' Fitzpatrick writes, 'its new meaning was filled out with ideas derived from influential contemporary trends, notably environmentalism, alternative health and New Age mysticism (Biss, 2014, p. 133).

Here we see how the metaphoric phrase *immune system* had us forget it was a metaphor and had us take it for fact. This is not to say that a gradual change of meaning that reflects societal and cultural change renders language meaningless—far from it. The ability for language to warp and change alongside its culture is a testament to its aliveness. Words are variable, mutable, interpretable. It is far more a problem when a word can change in meaning at whim, or when context provides no illumination of a word's meaning, as is quite often the case of plastic words. Plastic words mimic aliveness of language in their mutability but are hollowly ahistorical, story-less and will differ from context to context, mouth to mouth. Words can have many different *interpretations*, but plastic words *mean* many different things. For a plastic word, there is no unanimous consensus of definition.

Invasive Species

Invasive species are considered non-native species that are, have or will become injurious to the region into which they are introduced. It is more likely that non-native species will become injurious for several reasons, including: wide dispersal, generally high tolerances, lack of native predators and general unpredictability of their presence in a new region (Verbrugge et al., 2016). Climate change and anthropogenic factors increase the dispersal of invasive species to an unprecedented degree, and immediate action is often required to prevent potentially disastrous environmental or socio-economic degradation (Verbrugge et al., 2016). A discourse exists around invasive species management that makes it difficult to conceive of alternate options or narratives, and the current discourse raises confusion, inaccessibility and misleading terminology.

Invasive Species and Metaphor

Today, invasive species management looks to minimize confusion in its discourse. The Invasive Species Definition Clarification and Guidance White Paper (2006) attempts to clarify terms and definitions (See Appendix 5). While the current definitions seek to avoid specialized terms and scientific jargon, invasive species management discourse is still rife with plastic words and militaristic metaphors. To begin unpacking the invasive species paradigm, it is essential to dissect the term and terminology associated with *invasive species*.

Technical Definition

According to the National Invasive Species Council (NISC), Executive Order 13112 defines an invasive species as: 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or

environmental harm or harm to human health (NISC, 2016). While this definition might appear straightforward, it is worth unpacking. Let's begin with the assertion that an invasive species must be non-native.

An invasive species is: non-native (or alien) to the ecosystem under consideration

Determining the true nativity of a species is difficult, as credible historical data to determine nativity is fragmented and brief. Many species we consider native have their origins elsewhere. The further back in time we go, the less relevant the term *native* becomes. One need only consider the origin of all life beginning in the ocean to recognize all land-dwelling species as "invasive". In the article "The Rise and Fall of Biotic Nativeness: A Historical Perspective" co-authors Matthew K. Chew and Andrew Hamilton (2011), deconstruct the concept of nativity in invasion biology, arguing that it is a weak, contingent, and variable paradigm that leans heavily on subjective human bias (Chew & Hamilton, 2011). It is an ideal that presupposes that a species *belongs* in a singular locale. Fixing and fixating upon this *belonging* requires ignoring the ways in which species create habitats by evolving and migrating. Habitats are not passively awaiting organisms: organisms organize habitats. Richard Lewontin discusses this proxy in his book *Biology as Ideology* (1991). Unlike the theories in Darwinism which suggest this one-way street: that organisms are passive agents shaped by their active environment, Lewontin argues instead that organisms that thrive within habitats act upon their environments as much if not more than their environments act upon them. "Organisms" he explains, "do not experience environments. They create them. They construct their own environments out of the bits and pieces of the physical and biological world and they

do so by their own activities" (Lewontin, 1991, p. 109). Where and why does a given species belong to a specific place? Does a species belong solely to the location from which it first evolved? How can it be limited to that singular locale? Nativity is an old ideal, which sets a conservation goal of restoring ecosystems to pre-colonized states (Chew & Hamilton, 2011). This is an ideal born out of the separation of man from nature, instigated by the father of modern science Rene Descartes in the 17th century, and foundational for many underlying scientific beliefs. These puritanical ideals, with their myth of origins, aspire to fix and contain a volatile nature, a living world that is always shifting, changing, adapting and evolving.

An invasive species must: cause or be likely to cause economic or environmental harm or harm to human health.

Determining any extant harm is difficult and subjective. The word "health" is a plastic word, which exacerbates the confusion. These are words and concepts that can mean different things to different people. The National Invasive Species Management Plan (NISMP) recognizes this variability of these words, and offers The Invasive Species Definition Clarification and Guidance Paper (2006) in which they point out that while some people may consider a species harmful, others may recognize and reap benefits from that same species (ISAC, 2017). It follows that predicting the potential for economic or biological harm is difficult. The vagaries of definition are compounded by uncertain time-scales, which for an invasive species can be unpredictable. A non-native species can take many years before becoming invasive (Chaffin & Hamilton, 2006).

In ordered to be labeled invasive, a species can certainly be extremely destructive, like the Asian chestnut blight fungus (*Cryphonectria parasitica*) which swept across

35,000 square miles of the eastern United States in the 19th Century, killing almost all chestnut trees (*Castanea dentata*) in its path (Simberloff, 2003). But invasiveness casts a wide net, as some invasive species are less harmful than they are ugly. An invasive species' only sin could be that it has the potential to decrease property value, causing *economic harm*. Moreover, there is a dose a geographic alchemy, as an invasive species in one region will be similarly labeled in another, far-distant region. In Australia, non-native devil's claw (*Martynia annua*) has been the costly subject of ecological eradication efforts for over 20 years even though research has found no evidence to suggest that devil's claw contributes to loss of biodiversity or interferes with nutrient cycling, at least in Australia (Davis, 2011). Harm of capital and economy are directly planted in this definition of invasive species. Vandana Shiva writes in her text *Monocultures of the Mind: Perspectives on biodiversity and Biotechnology* (1993) of a classic example of how dominant knowledge systems can discount native plants as weeds if they are not economically viable to those dominant knowledge systems. In a soundbite from a statement of an international forestry consultant speaking about an ecosystem of the humid tropics, she quotes "The important question is how much of this biomass represents trees and parts of trees of **preferred species that can be profitably marketed**…By today's utilization standards, **most of the trees, in these humid tropical forests are, from an industrial materials standpoint, clearly weeds**" (Shiva, 1993, p. 24). She further illustrates an extreme example whereby in India the native plant bathua (*Chenopodium album*) is considered a weed by dominant knowledge systems. Bathua is a native crop, nutritious and especially rich in Vitamin A but poses threat to the growth of the more commercially viable wheat plant. Wheat has a high market value internationally

while bathua is praised locally. Because Bathua and threatens productivity of wheat, it is "managed" with herbicides. Meanwhile, 40,000 children go blind in India each year because they do not have enough Vitamin A in their diets. These herbicides also kill the wild reeds and grasses that rural Indian women use to make baskets and mats—a source of income for these local people. When dominant knowledge systems are designed based on market value and monetary gain, local perspectives of beneficial plants are negated if those plants threaten commercial gain (Shiva, 1993). Shiva writes, "The one-dimensional perspective of dominant knowledge is rooted in the intimate links of modern science with the market" (Shiva, 1993, p. 27). In invasive species management, like many disciplines in our capitalist society, we are largely inclined to think with our wallets. Environmentalist and philosopher TJ Demos writes that perhaps we should "ecologize the economy rather than economize the environment" (Demos, 2016, p. 150-151). Technically, a species needs only to *potentially* decrease the value of a property in a different continent to be labelled as invasive. This is an affront that can warrant outstanding and costly prevention and eradication measures, in favor of potentially preserving bank. The prevailing mentality in invasive species management is an oversimplification of invasive species, and one in which more holistic assessments are largely ignored.

What are the boundaries and limits of what constitutes an invasive species? Let's reflect on ourselves, for a moment. Is it surprising to recognize that human beings neatly fit the technical definition of invasive species? We are a species originating from a single region but have since spread globally, becoming a largely non-native species. We inarguably contribute economic harm, environmental harm and harm to human health in

many different ways. Let's look at our impressive ability to change the very climate of our world. According to the 2016 Environmental Protection Agency report of Climate Change Indicators in the United States, anthropogenic fossil fuel burning and deforestation are the main contributors to greenhouse gases and global warming. This climate change alters the world and its historic functions, disrupts ecosystems, harms and kills human and non-human communities, decreases biodiversity, and decreases quality of life for people and non-humans all over the world (EPA, 2016). Human beings are therefore arguably the most dangerous invasive species in the world. As invasive biologist Brenden Larson muses "We may dislike IS [invasive species] because we observe something in their behavior that we dislike about our own", noting our similar tendencies to expand and spread (Larson, 2010). He argues that "We characterize IS [invasive species] as amoral in terms of numerous traits – aggressiveness and lack of control, in particular – that 'represent forbidden sides of human nature" (Larson, 2010). What we fear of them, what we dislike about their patterns of behavior and tendencies are what we fear and dislike within ourselves. We are invasive species, but we probably will not admit it.

Figure 5 I am not a weed

Conceptualized Definition

The technical definition of invasive species itself is complicated, but there is also a discrepancy between this technical definition and the conceptualized, practiced or effectual definition. The words used to discuss and describe invasive species are widely varied; even the term invasive species has many synonyms. In an article designed to determine a neutral terminology for invasive species, Robert Colautti and Hugh MacIsaac identified over thirty terms that are used to discuss invasive species, many of which are used interchangeably with the term invasive species itself (Colautti & MacIsaac, 2004). Table 1, drawn from their article, lists these terms. There seems to be hardly any meaningful distinctions between these terms.

Table 1 List of some common terms in the English literature on invasion ecology, and their corresponding 'stages'

Term	Stage
Adventive	Stage I–V
Alien	Stage I–V
Casual	Stage II
Colonizing	Stage IVa
Cryptogenic	May be modelled as Stage III–V
Escaped	Stage II–V
Endemic	Not defined by the model
Established	Stage III–V
Exotic	Stage I–V
Foreign	Stage I–V
Immigrant	Stage I–V
Imported	Stage I–V
Introduced	Stage I–V
Invasive	Stage IVa, IVb or V
Native	Not defined by the model
Naturalized	Stage III–V
Nonindigenous	Stage I–V
Noxious	Not defined by the model
Nuisance	Not defined by the model
Pest	Not defined by the model
Spreading	Stage IVa
Temporary	Stage II
Tramp	Not defined by the model
Transferred	Stage I–V
Transformer	Not defined by the model
Transient	Stage II
Translocated	Stage I–V
Transplanted	Stage I–V
Transported	Stage I–V
Travelling	Stage I
Waif	Stage II
Weedy	Not defined by the model

Table 1 Invasive Species Synonyms

After analyzing the historical use of invasive terminology, Mark Davis (2009) argues that the current definition of invasive species is varied, poorly articulated and differs across cultural, political and regional borders (Davis, 2009). Davidson M. Richardson (2011) lists operationally defined invasive species terms in the text *Fifty Years of Invasion Ecology: The Legacy of Charles Elton.* Richardson also asserts that invasion terminology differs widely across spatial and temporal scales. Before listing his key terms (which extend for almost nine full pages), he explains that his motive for establishing this list grew out of the varied and uncritical use of terminology in invasion biology. He argued that the use of uncritical terminology serves to impede developments in the field (Richardson, 2011). Invasive species management must reckon with the fact that any discussion cannot rely on the shared understanding of any of these terms or their definitions.

In short, the technical definition of invasive species is vague and subjective. The terms associated with invasive species are variable and complicated—many different words may mean the same thing while a single word may mean many things. Invasive species is word that replaces more specific terminology, and lack of meaningful distinctions between synonyms. It is a word used uncritically. It is metaphoric, linking science with common ideas of everyday life. In this way, invasive species seems like a plastic word. It is not true plastic, but carries many similar characteristics, of which it is wise to be wary.

Despite these multifaceted definitions and terminologies, there is a prevailing singular way of looking at invasives—as a threatening "other" that must be eradicated to

preserve borders around “pure” ecosystems and environment—that is perpetuated through military metaphors.

Military Metaphors

The current invasive species narrative relies heavily on militaristic metaphors. Military metaphors are manipulative and generate biased implications which can be easily overlooked or ignored because they are so pervasive and influential. Let us explore in depth how this militant lexicon has come about.

In his book, *Invasion Biology* (2009), biologist Mark A. Davis contests the dominant invasive species narrative and historicizes how invasive species have come to be defined. The earliest recognition of an invasive species is undoubtedly impossible to determine. Species migrate and spread, and have done so for millennia. When humankind generally ceased its nomadic habits and settled, it is not unlikely that through observation of their surroundings, our ancestors noticed the effects of introduced species established through migration or anthropogenic trade. Our curiosity about invasive species most likely goes back many thousands of years (Davis, 2009). However, the first known references to non-native species in western science occurred in the 18th century during the end of the Age of Discovery. Davis refers to a student of Carl Linnaeus who hoped to bring non-native species to Sweden to grow for profit, as well as to Peter Kalm (1716-1779), who recorded the presence of European species he recognized in North America. Davis notes how geographer and naturalist Alexander Humboldt (1769-1859**)** recognized and recorded a global spread of certain species during his travels (Davis, 2011). Early

encounters with these organisms (which would later be known as invasive species) had an air of general curiosity, exciting discovery, and a desire to document and remember.

Biogeography

The emergence of biogeography, a discipline that focuses on the global migration of flora and fauna, turned travelogue and anecdote into a more systematic examination of native and non-native species. In particular, biogeography divided the globe into six distinct regions, each characterized by differences in climate and environment. The divided globe of biogeography may have helped bring about the concept of singular and permanent *native* species, a complex phenomenon given the tendency of species to regularly and obviously migrate between regions and across borders (Davis, 2009). In this new regional order, species were condemned to originate from a singular location. Botanist John Henslow is thought to have coined the term *native* in 1835. Its use rapidly grew—just over a decade later, botanists had begun using terms *alien* and *native* to describe plant species (Davis, 2011). In the 1860s there was recognition and discussion among agricultural scientists in the United States that non-native species could be harmful to native species, but so too was there a desire to "procure, propagate and distribute…new and valuable seeds and plants" according to the first mission statement of the United States Department of Agriculture (USDA) when it was created in 1862. By the early 1900s, the harmful effects of particular non-native species were more widely understood, and the militarization of the botanical lexicon began to emerge, particularly with the initiation of the Plant Quarantine Act of 1912 and the establishment of the Plant Quarantine and Control Administration of 1928 (Davis, 2009). These policies have enabled the growth of a singular obsession to fight against invasion by non-native

species. Preservation of nativity began as a way to protect against biodiversity loss, but it would begin to fuel a militant overtone, a case of *us* vs *them*. In *Borderlands/La Frontera* (1987), Gloria Anzaldúa alludes to the othering effects of borders: "The U.S.-Mexican borders *es una herida abierta* where the Third World grates against the first and bleeds. And before the scab forms it hemorrhages again, the lifeblood of two worlds merging to form a third country—a border culture. Borders are set up to define the places that are safe and unsafe, to distinguish *us* from *them*" (Anzaldua 1987, p. 3). This separation between lands—between the *us* on one side and the *them* on the other would perpetuate xenophobic or nationalistic way of thinking, even within the realm of invasive species.

Xenophobic Effects

It can hardly be surprising that a militant war metaphor would result in xenophobia. Writer James Geary, in his book *I is an Other* (2011), describes an experiment studying the social effects of using a body metaphor to explain a country. There were two groups in the experiment. One group read an article about certain airborne bacteria as omnipresent and harmful to humans, while the other group read about the omnipresence of other bacteria that was *harmless* to humans. Then both groups read articles on United States history; in which there was no mention of immigration. However, one article relied on a metaphor that described the United States as a body—using phrases like the country was experiencing a *growth spurt*, the country was *digesting* innovations—while the other article did not rely on bodily metaphors. Both groups were then made to fill out a survey, in which several questions referred to immigration. Those who had read the article with a body metaphor expressed concern over and negative

opinions of immigration. Interestingly, the group that read that airborne bacteria was harmful to health had more positive views of immigration because it was this group that had read the article that *did not* rely on the body metaphor. The results from this study suggest that priming a person about a topic (like personal health) will likely determine their attitude about some entirely different topic (like immigration) if these topics are linked metaphorically (Geary, 2011).

Daniel Simberloff writes of a particularly unsettling example of nationalism in invasive species management. In 1932, two garden architects created a Nazi campaign to "cleanse the German landscape of unharmonious foreign substance [plant species]" (Simberloff, 2003, p. 181). This botanical cleansing parallels the Nazi ideology of ethnic cleansing (Simberloff, 2003). In the early 20th century, Jen Jensen, an immigrant from Denmark to the United States, spoke of his garden in manner to suggest how nationalism and racism can invade the invasive species dialogue. Although he initially embraced non-native species, he later grew to oppose them. He said that he longed for his gardens to exist, "in harmony with their landscape environment and the racial characteristics of its inhabitants", and that "they shall express the spirit of America and therefore have to be free of foreign character as far as possible" (Simberloff, 2003, p. 183). He bemoans how "the Latin and the Oriental crept and creeps more and more over our land, coming from the South" and that "the Germanic character of our race, of our cities and settlements was overgrown by foreign [character]" (Simberloff, 2003, p. 183). "Latin" he argues, "has spoiled a lot and still spoils things every day" (Simberloff, 2003, p. 183). These are clearly xenophobic utterances of a gardener dismayed at the presence of invasive species in his garden. The war metaphor can exacerbate this xenophobia. Lorraine Daston and

Robert Galison write of how xenophobia and racism occur within a native botanical context. They write of the popular race-atlases created by Julius F. Lehmann (1864-1935), self-proclaimed of the far right political sphere. Lehmann, who would publish works in genetics, eugenics and racial hygiene, created medical atlases for the wide-spread Medical journal Munich Medical Weekly. He later found success creating racial atlases, which described physical characteristics to determine race. Lehmann wrote, in 1920, that he wanted to publish a "human field guide to the flora (Excursions, flora) of Germany that, first of all, would layout the general racial markings in an exemplary fashion" (Daston & Galison, 2007, p. 338). Daston and Galison write of the parallel between people belonging to race and plants belonging to species, and explains how these race atlases "could train the eye to see people as belonging to races, as particular flowers could be seen in their taxonomic place…" (Daston & Galison, 2007, p. 338). During World War II, the Nazis would use Lehmann's work for their own eugenic devices.

In 1958, Charles Elton published *The Ecology of Invasions by Animals and Plants,* in which he painted invasive species in vividly militaristic terms. His first sentence exemplifies this militant mentality: "Chapter One: The Invaders. Nowadays we live in a very *explosive* world, and while we may not know where or when the next *outburst* will be, we might hope to find ways of stopping it or at any rate, *damping down its force*" (italics mine, Elton, 1958, p. 15). Published in this post-war era, Elton's book is literally and metaphorically charged with visions of omnipresent of war and enemy. Similarly, following the 9/11 attacks in the United States of America, certain invasive species outbursts were compared to acts of terrorism (Larson, 2005). Elton's text inaugurates a fearful sense of dire urgency which prior discussions of invasive species

lacked, and subsequent texts paralleled these extremes. The reception of his text did not immediately instill a flurry of interest in invasion ecology research. Rather, it took a quarter of a century after its publication before invasion biology began to emerge as a new discipline, alongside the establishment of the *Scientific Committee on Problems of the Environment* in 1983. It may have been a slowly emerging discipline, but interest in the field has effectually surged since the 1980s. In its early instigation, the field was primarily fueled by interested ecologists who viewed the discipline through a niche-based ecological mentality in which species' specific roles are analyzed. In this, they weighted their research towards species separately and individually, largely ignoring more holistic regional or historical factors. (Davis, 2011). While it took time for Elton's book to take hold, the militarism of his vision was undoubtedly foundational to invasive species management. Invasions of species are now regarded as occurrences which must be battled.

Further Issues with the Military Metaphor

The term *invasive* itself is inherently militaristic. While militant language may serve to colloquialize the concept and spur support, it nevertheless enforces an aggressive combative approach to invasive species management, making it difficult for general negotiation with invasive species biologists (Davis, 2009). Biologist Brendon Larson explores these militaristic associations. He explains how our current framework for discussing invasive species management relies on the power of metaphor to generate a unanimous understanding of invasive species. He adds that this can be misleading to the public as it marks species metaphorically as malicious entities. Larson also points out how this violent way of thinking diverges from the prevailing green environmental

mentality of a harmonious co-existence between humankind and the world, and general conservation values. The militaristic language used to discuss invasive species instills a sense of urgency in management procedures, but can actually undermine conservation efforts. Larson explains this as a multi-faceted problem.

The metaphor of war requires one to imagine two opposing sides, and to harbor an *us* versus *them* mentality. This is contradictory given that invasive species are largely an endemic problem because of anthropogenic factors like human globalization. The *us* in this war facilitated the spread of *them*. We cannot be separated; we are the ones creating the invaders. The use of a war metaphor pits us at opposing sides, but our relationship with invasive species is complex and inherently entangled.

The metaphor of war suggests that there will be a winner, which is misleading. There will never be a return to purity of natives in an ecosystem, particularly as climate change and other anthropogenic factors continue enabling dispersal.

Such loaded military language may contribute to public resistance or distrust of those using this language. Science is supposed to be objective, and loaded language bears bias. A Pacific Northwest based study conducted on the role of ecologists in ecological management suggested that the public preferred ecologists to inform and educate, rather than argue for a particular mode of action (Larson, 2005).

Invasive species removal in certain areas of conservation or restoration will serve to benefit upper middle-class citizens, and may therefore be perceived as an elitist ecological pursuit. This class divide further distances the public from ecologists and conservationists, and perpetuates public mistrust (Larson, 2005).

In another Larson (2007) article, Larson argues that the current invasive species

paradigm perpetuates an obsolete way of thinking about ecosystems as stable systems rather than as changing entities eternally subject to ecologically necessary disturbances. He also emphatically argues against Cartesian dichotomy between humankind and nature. He challenges us to recognize our role in the creation of such paradigms (Larson, 2007).

The militarization of the discourse around invasive species creates a generic sense of otherness, and the invasive *other* seems to fall outside of natural law and is therefore unnatural or alien. However, the notion that any species is alien and must be eradicated seems itself to be an extremely unnatural vision for the natural world (Larson, 2007).

This singular vision has largely endured since the instigation of invasion biology as a discipline. But the militarized language that structures the invasive species paradigm should not be the sole and enduring conceptual basis of the field. It is overly rigid, misleading and perhaps outdated. We need new ideas to evolve the paradigm (Davis, 2011). The term *invasive* interferes with our ability to imagine how some of these species might be able to help rather than harm.

Managing Invasives

Generally, our mode of invasive species eradication is to act rapidly and mercilessly to preserve local ecology and habitat. This way of eradication is laudable and inarguably helpful in preventing an array of environmental harms and biodiversity loss—which is one of the largest ecological threats to our world. However, this way of eradication offers a complex challenge, both moral and practical.

Project Isabela offers one of the most controversial invasive species management tactics I've come across. It involves the complete eradication of an invasive goat species (*Capra aegagrus hircus*), left on the Galapagos island as a backup food source for

fishermen in 1959. By 1997, the three goats the fishermen had left had become over 100,000, and had degraded the landscape and habitat of the island to an extreme degree. To save what they could of the deteriorating islands, a multi-agency project entitled Project Isabela was set into motion. The project suggested that the best way to preserve and restore the landscape would be to shoot all the goats, on foot and from helicopters. In order to make sure that every goat was eradicated, the snipers left what they referred to as a "Judas goat". The helicopter, having come across a goat pack, would slaughter all but one goat, the "Judas goat". Goats are pack animals, meaning they take comfort with their own kind. So after its kin were slaughtered, this Judas goat would seek out other goats, and the snipers would simply track down the Judas goat and slaughter another pack. They would leave the Judas goat alive, and repeat until every goat was eradicated from the Galapagos islands (Hirsch, 2013).

This is a dramatic examples of invasive species management. The invasive Galapagos goat wrought nearly irreversible destruction upon the landscape it inhabited, but I cannot imagine anyone who could not cringe from the thought of a Judas goat repeatedly seeking out its kin only to see them shot down, again and again, around it. Similarly, in the old growth forests of the West Coast, the invasive barred owl (*Strix varia)* is shot down to save the local and endangered spotted owl (*Strix occidentalis*). In conversation with a scientist in charge of shooting down an owl to save an owl, biologist Lowell Diller admitted how the experience of shooting down owls has shaken him emotionally, that every time he shoots an owl, he feels in his heart that he is doing wrong (Shogren, 2014). There is no easy solution to invasive species and the ecological

destruction they cause. These are controversial, and truly ethical dilemmas. I bring them up only to offer a chance for contemplation.

There are several recent studies which suggest how accepted modes of eradication can have unintended and counterproductive consequences.

A 2016 study entitled "Potential Problems of Removing One Invasive Species at a Time: A Meta-Analysis of the Interactions Between Invasive Vertebrates and Unexpected Effects of Removal Programs" conducted by Sebastián A. Ballari, Sara E. Kuebbing and Martin A. Nuñez explores how the eradication of a single invasive species causes harm to native species in an ecosystem as opposed to eradication of multiple at a time (Ballari et al., 2016). They explain that "the removal of a single invasive species always led to a negative or neutral mean effect on native species performance or survival" and "never found a positive effect size where the removal of one invasive led to an increase in native performance" (Ballari et al., 2016). This study exposes the fundamental problems with hasty action.

Further, by destroying invasive species before they can cause any harm we also lose the opportunity to examine an ecosystem's potential resilience, or possible long-term benefits of invasive species. Tomás Carlo partnered with Jason Gelditsch in a 2011 study conducted to determine how sometimes invasive species work within their introduced ecosystems to form mutualisms—mutually beneficial relationships with native plants. Gelditsch and Carlo found that the honeysuckle plant (*lonicera*), which was invasive to the region of their study, actually began to form these mutualisms with native bird populations and with a native plant species (Gleditsch & Carlo, 2011). Carlo argues in an interview that, given time, some invasive species may slip into empty niches of damaged

ecosystems and can actually help rebuild and strengthen biodiversity in a natural self-sufficient way that generally does not require much intervention by humans. Our current mode of eradication is also costly, time consuming and often unsuccessful. Carlo pushes this point further by explaining that attempted eradication can be a waste because often the invasive species will return ("Invasive plants can cause", 2011). Carlo explains that "Nature is in a constant state of flux, always shifting and readjusting as new relationships form between species, and not all of these relationships are bad just because they are novel or created by humans,' Carlo said. 'We need to be more careful about shooting first and asking questions later—assuming that introduced species are inherently harmful. We should be asking: Are we responding to real threats to nature or to our cultural perception and scientific bias?" ("Invasive plants can cause", 2011). With enough time, might certain invasives integrate within local communities and prove beneficial as the ecosystem adjusts? Are many of our efforts ultimately a waste of time, money and effort? Tomás Carlo reaches a similar conclusion to the Ballari et al., study: that sometimes destroying an invasive species serves to disrupt "newly formed balance of an ecosystem" ("Invasive plants can cause", 2011).

And yet slowing down to consider harm, failing to act quickly, can result in irreversible environmental devastation. It is a complex problem, for which I argue a greater, more open conversation within a more social and democratic science may help. The term *invasive* and its militaristic undertones may get in the way of alternative perspectives, providing overhasty eradication efforts that are either unnecessary or provide more ecological damage than the presence of the invasive species.

Ultimately, the militaristic paradigm is one of conformism. There is an instinctual fear of the other, of that which is unknown or different, and we can see how the metaphoric militarization of invasive species feeds off of one of humankind's greatest fears. H.P Lovecraft, legendary horror writer states that "The oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown" (Lovecraft, 1973, p. 12). In thriving off this intrinsic fear, this militant metaphor is prevalent, and effectually starves out other frameworks. Our current invasive species story treats invasive species as a kind of malicious entity acting outside natural law in order to war against a pristine, stable, innocent ecosystem. In order to protect this ecosystem, reductionist descriptions that rationalize the extermination of invasive species is required. This is ethically, economically, ecologically and practically problematic. This militaristic metaphor is an exacerbation of the symptom that suggests that human beings are indeed separate from nature. In his essay "Getting Along With Nature", farmer Wendell Berry writes: "even as conservationists, we see the human and the natural economics as necessarily opposite or opposed, we subscribe to the very opposition that threatens to destroy them both" (Berry 2009, p. 18). This discordant *us* vs *them* falls apart when we remember how anthropogenic invasive species are. As invasive species management continues to move forward, its practitioners should seek consensus even as they narrow and refine their terminology and broaden their metaphors. Instead of generalizations based on war, a nuanced and democratic language will help to reinvent the metaphorical representations of invasive species and their management. The invasive species paradigm is a complex one, for which a singular militaristic narrative serves to undermine, simplify and violently misrepresent the reality of invasive species. There are

other ways of knowing and describing these complex phenomena which might replace the current terminology.

Another Narrative for Invasive Species

Invasion ecology is a relatively new discipline. Interest in the field has exploded in the last 25 years, and its narrative is still being written (Richardson, 2010). By 2010, the US was spending $120 billion on invasive species, while the global cost was 5% of the $1.4 trillion world's economy (FWS, 2012). Although these staggering figures fuel the widely accepted claim that invasive species are the second leading cause of biodiversity loss next to habitat destruction, A 2004 study notes that there is very little data to support this conclusion (Wilcove, Rothstein, Dubow, Phillipd & Losos, 1998). Wilcove et al., show that the data for the United States is skewed by the inclusion of information about Hawaii, which experiences more drastic biodiversity loss because it is an island (Wilcove et al., 1998). Mark Davis compares this claim to a similar Canada-based study, which shows that invasive species contribute minimally to biodiversity loss (Davis, 2010). Although invasive species can be harmful, the general panic is overblown, and alternate perspectives are emerging. Today, as climate change shifts the earth and globalization reveals the depth of connectivity between natural and social systems, we are faced with the task of reevaluating many of our pre-established management practices.

Invasives and Resilience

A 2016 article entitled, "Biological Invasions, Ecological Resilience and Adaptive Governance discuss the ways by which the current narrative ignores a more holistic way of understanding ecosystems" highlights the ways by which invasives can serve to

strengthen ecosystems. The authors argue that the war narrative has created a management approach that is focused on pure reductionism of invasives followed by difficult restoration projects (Chaffin, Garmestani, Angeler, Herrmann, Stow, Nystrom, Sendzimir, Hopton, Kolasa & Allen, 2016). This agenda largely overlooks ecological resilience of ecosystems. Chaffin et al., suggest, like the Ballari et al., (2016) and Gelditsch and Carlo (2011) studies, explain that while invasives can reduce the resilience of ecosystems by decreasing biodiversity, invasives can also increase the resilience of ecosystems, and it is this ability to increase resilience that is largely ignored. While Chaffin et al., (2006) attempt to describe three different ways in which invasive species can serve to increase the resilience of an ecosystem, I recognized how these different ways easily bleed into each other, and I could distinguish more certainly two main points from their article.

First, invasive species can help a depleted ecosystem recharge and gain strength by fulfilling certain functions that were in some way stressed or degraded. They offer the example of the European green crab (*Carcinus maenas*) invading the waters of eastern United States. Overfishing of predators of a native crab (*Sesarma reticulatum*) has enabled Sesarma to deplete the marshes. The invasion of Carcinus contributes to predation of Sesarma, which in turn helps restore native marshes to their previous ecological niche (Chaffin et al., 2006). This example suggests how a native species may be experiencing hyper-growth because a niche that prevented that species from experiencing such growth is lost, and an invasive has the potential to fill the niche that will prevent that hyper growth and thus return the system back to normal.

Second, an invasive species can reinforce certain beneficial functions or roles

already present in ecosystem through a process of redundancy. Chaffin et al., (2006) discuss the vertebrate fauna in the Florida everglades. The native vertebrate fauna experienced a decline, while non-native vertebrate fauna is spreading. Despite these changes, the ecosystem remains wholly unchanged. These invasions reinforce certain functions that another native species contributes and therefore acts as an extra component that benefits the ecosystem. Therefore, if the native species that provides this beneficial function experiences an alteration or extinction or extirpation, the invasive species can supplicate that species.

Ultimately it is important to consider that any effect on an ecosystem may have a temporal delay. It takes time to see how an invasive species might affect an ecosystem, so any immediate effects, either beneficial or harmful could potentially be temporary.

The Holistic Framework

Chaffin et al., argue that an awareness that ecosystems function on temporal and spatial scales is necessary in invasive species management. This level of management can be achieved, he argues, through adaptive, decentralized governance in which communication between public, organizations, and institutions flourishes. This author interprets this point as a call for a more democratic science. The authors also advocate for a shift away from management of individual species to a model based on ecosystems (Chaffin et al., 2006). Brendon Larson similarly argues for a holistic approach in invasive species management. He explains that we need to remember that our narrative is interwoven with the narrative of invasive species—they are not an unnatural other and their omnipresence has anthropogenic causes (Larson, 2005). This narrative collapses the divide between culture and nature, and puts to rest the othering effects of military language. Larson argues for a new metaphor to be threaded into the current invasive species narrative, one which might foster a more holistic way of thinking. He compares the way by which traditional Chinese healers think about diseases in terms of balance, harmony and even encourage being kind to infections, to the way by which more traditional Western medicine uses a militaristic metaphor to conceptualize disease. If we were to adopt Larson's approach, we would have to recognize the anthropogenic agency in the prevalence of invasive species. Most remarkably, metaphors like these would offer us a chance to reintegrate ourselves into the natural world (Larson, 2005). For example, James Lovelock's depiction of the Gaia hypothesis suggests that each organism and interwoven habitat within the world create a self-regulating and resilient global ecosystem ("Gaia Theory", 2018). Joanna Macy employs a four-fold analytic framework

by which we view the world: as a battlefield, as a trap, or as a lover or as the self (Macy, 2007). These examples provide alternate frameworks, alternate narratives by which we can conceive of our self and our world.

Current frameworks focused only on niche-based comprehension of invasive species generally ignore the ecosystem as a whole, both temporally and spatially. While certain components of ecosystems might break down with the introduction of invasive species, other components may be strengthened. Further, treating the ecosystem as a holistic entity encourages the public and natural resource agencies to break out of the obsolete way of thinking about ecosystems as rigid stable structures that must be maintained and which crumble when change occurs, to instead perceiving them as living entities in constant flux and growth.

Climate Change

Mark Davis argues for reconsideration of what constitutes an invasive species in light of climate change. Although many invasives and non-natives result from anthropogenic factors, climate change also spurs the migration of species into new areas (Davis, 2013). There are ecological and ethical considerations that must be taken into serious account when attempting to eradicate or prevent the introduction of these immigrant or refugee species which flee their homes because anthropogenic forces have made their homes inhospitable. Two years ago in May, when I was on a break from work in downtown Olympia, I joined a small crowd gathered on a wharf to observe about half a dozen dolphins who had entered Budd Inlet. I later spoke to a local who said this was the first time the ‘common dolphin’ (*delphinus***)** had been seen anywhere in the Puget

sound in recorded history—and they had made it all the way to the southern tip of the inland waters, far from their native regions which were getting too warm (Miller, 2016). Davis alludes to the way by which our modern changing climate will distort the static distinction between *native* and *non-native* and to the possibility of native species acting in ecologically harmful ways. He cites the case of the mountain pine beetle (*Dendroctonus ponderosae*) which is native to the United States, but has become an epidemic, particularly in the Rocky Mountain region (Davis, 2013). Here, a native species acts invasively, but does not fit the technical definition of *invasive*. Further, the beetle is being treated, managed and referred to as an invasive species. Conversely, climate change enables previously invasive species to become less harmful. Davis refers to the larch bud-moth (*Zeiraphera diniana*) which has exhibited ecologically problematic outbreaks historically except between the years 1981 and 2007, when no outbreak was recorded. Studies suggest that warmer weather has decreased these problematic outbreaks. This strongly suggests that invasiveness is a contingent rather than an ontological category, subject to changes in definition as climate change continues to alter ecosystems. There is no escaping the fact that when native species decline, the ecosystem may actually benefit from introduced species that serve to replace that native species' functions (Davis, 2013).

Climate change provides a remarkable opportunity to reevaluate old, potentially outdated and obsolete models by which we structure many of our management practices. How we determine, handle and manage invasive species must be re-evaluated and contextualized. There are invasive species that are extremely harmful, and contribute to biodiversity loss as they extirpate or cause the extinction of species that are not able to adapt to the presence of non-native species. This is not debatable. Nevertheless, a

paradigm shift is called for so that we might more logically, holistically, ethically and appropriately consider the effects of invasive species (Weins, 2009).

There are gaps in extant literature about how different entities involved in invasive species management communicate their work. There is also little discussion of how metaphor and abstract and inaccessible language unite to keep a singular narrative in power. While there is literature that touches on the militaristic metaphors in invasive species management, there is nothing that discusses or records the use of plastic words in invasive species management. Plastic words are largely unexamined in critique of scientific language in general. My thesis explores and bridges these gaps, and integrates and contextualizes these bridges within the existing invasive species management narrative.

Chapter 3: Methods

To answer my question: what are the foundations, implications and effects of misleading metaphors and inaccessible language in invasive species management nomenclature?, I chose an approach that would incorporate several different methods. My work is transdisciplinary, in that I have incorporated "natural, social and health sciences in a humanities context", transcending disciplinary boundaries (Choi and Pak, 2006). In order to respect each discipline in play, and to explore my research question from a variety of different perspectives, my thesis has required multiple research methods. My thesis relies on a mixed-methods approach, incorporating general and contemporary research, qualitative and quantitative analysis of coding and surveys, and unstructured interviews(s). I also employ humanist and literary methods of analysis, specifically Franco Moretti's 'distant reading' by which I am able to map key concepts and words pertaining to my hypothesis within a wide variety of texts (Moretti, 2013).

For my literature review and background, I read many different texts both historical and contemporary on the subjects of science and feminism, of classification (of species, regions and language), on invasive species, on militaristic metaphors in general and as used in invasive species management, on metaphors in general and as they are used in science, on plastic words and other forms of scientific language. I have read various texts that expose the effects of this language in a variety of scientific disciplines to frame, bias and otherwise persuade of a specific opinion. These texts included interviews, non-fiction and fiction texts, essays, speeches, and public documents. I used Atlas.ti to find examples and frequency of plastic words and metaphoric terminology used in invasive species documents and in public articles. I created a purposive survey of

25 individuals with varying degrees of familiarity with the type of language that is used in science writings. This survey asked participants what they think is being said in a portion of a particular invasive species document. I also used Mechanical Turk to survey 100+ individuals, asking the same questions. I interviewed an individual whose job is to "translate" scientific documents into articles that are more accessible. After collecting and learning from this data, I performed a series of my own original translations of the document I gave to survey participants, in order to rephrase and eliminate plastic words, scientific jargon and/or militant metaphors. I explored what meaning is lost and gained in this translation.

Invasive Species Management Documents

The key documents I focused on were works created for the public—easily accessed on the National Invasive Species Information Center website. The documents I chose include: *Executive Order (E.O.) 13112 – Invasive Species* (1999), *Five-Year Review of Executive Order (E.O.) 13112 on Invasive Species* (2005), *Invasive Species Definition Clarification and Guidance White Paper* (2006), *The Standard Operating Procedures (SOP) for the Rapid Screening of Species' Risk of Establishment and Impact in the United States* (2016), *Executive Order 13751 Safeguarding the Nation from the Impacts of Invasive Species* (2016), and the *Management Plan Report Card* (2017). I also included two documents from the Federal Trade Commission website, to provide a mirrored comparison within another discipline. The documents I chose for an economic perspective are: *A Brief Overview of the Federal Trade Commission's Investigative and*

Law Enforcement Authority (2008) and *Federal Trade Commission Draft Strategic Plan* (2017).

What follows are summaries of the point and purpose of each document:

Executive Order 13112 – Invasive Species (1999)

In 1999, the president of the United States of America created, in collaboration, Executive Order 13112 to bring to light and address how non-native species upset certain perceived harmonies between human, plant, animal, and land. This document begins by defining terms that will be used, establishes the Invasive Species Council (ISC) and explains its duties, and requests the first National Invasive Species Management Plan (NISMP) which will be continually reviewed henceforth, and ends by explaining the purpose of this Executive Order and revoking previous incompatible Executive Orders (See Appendix 3).

Five-Year Review of Executive Order 13112 on Invasive Species (2005)

This document is released every five years and is a review of the 1999 Executive Order (EO) 13112. This document assesses how effective the EO is and whether or not it should be revised. It summarizes EO 13112, explains and defines invasive species as they are perceived today, and examines how well the EO 13112 holds up. It examines the particular roles both the Invasive Species Advisory Committee (ISAC) and the NISC have, budgets, and various prevention measures. The conclusion of this report suggests that the NISC is working well to meet certain goals outlined in the EO 13112, and that in future the NISC will be able to address invasive species more effectively, despite

challenges in interagency collaboration. It argues that Executive Order 13112 should be maintained (See Appendix 4).

Invasive Species Definition Clarification and Guidance White Paper (2006)

This document defines invasive species while acknowledging the difficulty of defining invasive species. It explains that "harm" is subjective and certain people may find a species harmful while other people may find that species beneficial. It suggests negative effects shall outweigh beneficial effects of a non-native species to deem it invasive. It discusses what is meant by native and non-native, how federal non-native species are more often potentially invasive than domestic non-native species, how a certain region may have negative effects from a non-native species while another, nearby region may have beneficial effects, and describes the various types of harm invasive species can inflict on: the environment, human health, natural resources, and recreational avenues (See Appendix 5).

The Standard Operating Procedures for the Rapid Screening of Species' Risk of Establishment and Impact in the United States (2016)

This document describes a streamlined Standard Operating Procedure (SOP) to screen the potential risk of a non-native species. This procedure, if done properly, helps determine if a species can be labeled as "invasive" which would warrant regulatory action such as preventative measures or attempted eradication of that species. It describes who is best fit to perform these procedures, and on what sorts of species. It defines invasive species, and explains the difficulty in defining invasive species. It describes the purpose of the paper as to be guidelines for a procedure that can be replicated. It discusses difficulties in streamlining such a process. It describes the appropriate format

by which a successfully enacted analysis should adhere to, including information on: nativity of species, ecological and biological information, impacts of introduction, global distribution, United States distribution, climate matching, certainty of assessment, risk assessment, and references. It offers an example of a successfully conducted risk assessment procedure as a template (See Appendix 6).

Executive Order 13751 Safeguarding the Nation from the Impacts of Invasive Species (2016)

This document from 2016 amends the Executive Order 13112, by expanding the NISC, clarifying NISC duties, reviewing and clarifying subjective invasive species definitions, and incorporates new technologies, changing climates, and other contemporary divergences from EO 13112. It defines terms used in the document, describes federal agency duties, assesses new emerging priorities and makes various amendments to EO 13112 (See Appendix 7).

Management Plan Report Card (2017)

This is a brief outline of the current plan for handling invasive species and their effects on humans, regions, economies (See Appendix 8).

A Brief Overview of the Federal Trade Commission's Investigative and Law Enforcement Authority (2008)

This document explores the regulations, expectations, roles and investigative procedures of the law enforcement branch that deals with issues within the Federal Trade Commission (FTC). It begins by describing elements of the FTC act, then elaborates on how to handle a variety of unfair business practices that harm consumers (See Appendix 9).

Federal Trade Commission Draft Strategic Plan (2017)

This is a detailed outline of a three-part plan for 1) protecting consumers against unfair business practices, 2) promoting competition in the marketplace, and 3) generally strengthening the FTC's reach and scope through strategic dissemination of information (See Appendix 10).

Data Analysis

I coded these documents using the software program Atlas.ti. In my coding process, I looked specifically for the frequency of inaccessible language in the form of Poersken's plastic words. I created codes for the following words:

Table 2 Plastic Words list

Plastic Words
accomplishment
basic needs
capitalization
care
center
communication
consumption
contact
decision
development
education
energy
exchange
factor
function
future
growth
health
identity
information
living standard
management
modernization

model
partner
planning
problem
process
production
productivity
progress
project
quality
raw material
relationship
resource
role
service
sexuality
solution
strategy
structure
substance
system
value
work
workplace

Language may be likened to an organism that changes over time. Language is alive. Philosopher Ludwig Wittgenstein (1889-1951) has written, “The meaning of a word is its use in the language” (Wittgenstein, 1958, p. 14). Meaning does not precede use. With changing usage and context, certain words can become more plastic while formerly plastic words can lose their plasticity. Uwe Poersken admits that this list is not comprehensive, and certain words are questionable. But there is an aura around them, a taste of them, and they have a certain feel that may not be provable scientifically, but recognizable. In my analysis I focused on the list of plastic words discovered by Uwe Poersken, but allowed for variations of those words, such as present and past participle. For example, I looked for develop, but allowed for developing, developed and

development. While using these criteria to code, I found several other variations of the words I had chosen. The coding software picked up on these variants in the documents and responses I scanned:

Center: Human-centered, center-point

Identity: president, presidential

Produce: reproduction

Solution: resolution

Structure: infrastructure

Substance: substantial, substantive

System: ecosystem

Value: evaluate

Work: network, artwork, framework, working, workings, workshops, and paperwork

I deleted these occurrences because I did not have time to put them through Poersken's plastic words test of 30 criteria. I focused on prominence of extant plastic words. To see the types of words used most frequently in these documents, I created word clouds in Atlas.ti for each document. In word clouds, larger words appeared more frequently while smaller words appeared less frequently. To generate most frequently used words, the word cloud algorithm eliminates a list of extremely common words, like certain prepositions. Because each document had a different number of frequently used words, I created a threshold. The words which appear in the following word clouds appear at least 5% of the most frequently used words per document.

Goal

I chose these documents in particular because my question is about how science uses rhetorical and inaccessible language to tell its story to the public. These documents also cover a range of years without being, in my opinion, too far outdated. The main point of this coding was to find how often invasive species management relied on inaccessible language on their website and in their key documents.

Surveys

My survey was approved by the Evergreen State College Human Subjects Review Board to ensure that the questions offered no preventable risk to participants. The document I had participants read and respond to is a portion of a larger document entitled *Invasive Species Definition Clarification and Guidance White Paper* (2006). The portion I chose was the preamble, which introduces the document and intentions of the document which are essentially to 1) recognize the difficulty of defining invasive species and 2) define invasive species after this recognition of difficulty to define (See Appendix 11 and 12).

I surveyed a variety of people with differing degrees of familiarity with how invasive species are talked about. My survey asks participants to read a key document, and respond to a selection of questions that refer to the words used and general read-difficulty of that document. The survey consisted of nine questions, mostly short answer responses. I chose short answer responses as opposed to multiple choice answers, because I wanted my participants to be able to respond in a way that most reflected their opinions and beliefs. I wanted their responses to be written in their own words, not mine.

I chose a small sample of around 25 individuals, because I wanted to analyze in more depth their anecdotal responses. This was a purposive survey, in which I actively sought out a variety of people with a range of degrees of familiarity with how invasive species are talked about. For my survey, I emailed specific members of various groups, including the National Institute of Health (NIH), first year Masters in Environmental Studies as well as humanities undergraduate students at the Evergreen State College, members of a naturalist group in Washington D.C., people who work on environmental impact and risk communication, those who work in invasive species management, employees who analyze legal documents regarding the housing crisis of 2009, Bon Appétit magazine employees, Museum of Modern Art (MOMA) employees, ICF employees, and individuals who had previously been in the military. I have personal affiliation with the individuals I emailed, and asked these individuals to email the actual participants with whom I had no or minimal personal affiliation. This was done in order to minimize bias, though there remains potential for bias because I have personal affiliations with the individuals I emailed. Because I wanted to minimize my personal contact with the participants, I do not know how many people received my email, so I am unaware of the response rate. These participants should have been unaware of the specific nature of my research project.

I also used the survey software program Mechanical Turk to compile a larger random pool of 100+ responses. Mechanical Turk participants have a monetary incentive to respond to surveys. I was interested in comparing Mechanical Turk results to Purposive Survey results, analyzing for comparable patterns in responses, for frequency of plastic words as well as any noticeable effects of plastic words in responses, and

contrasting which sections and words were easiest to understand and which were most difficult for each cohort.

Data Analysis

To analyze the data, I compiled from my surveys, I used Atlas.ti to code responses, looking for patterns and themes in how readable the document was for participants. I generated word clouds of most frequently used words in responses in order to analyze more efficiently. The word clouds I generated do not have the same threshold as the word clouds I generated for the invasive species management documents.

Goal

My goal was to 1) discover which areas of the document were most difficult and which were easiest to understand, 2) discover which words were most difficult and which were easiest to understand, 3) discover how participants define invasive species after reading this document, and 4) provide participants the space and opportunity to reply honestly and in a way that most reflects their understanding and beliefs. This document contained a percentage of plastic words, and I was curious if these plastic words would come up in the survey responses. Because plastic words are both difficult to pinpoint a single definition, but seem familiar, I was curious if plastic words would come in both categories of easy to understand and difficult to understand. Ultimately, however, my concern is of comprehension, and I wanted to find out how language use may have impeded comprehension of this document designed for clarification.

Semi-structured Interview

I also chose to pursue an informal interview with someone who has worked in science writing and communication as their profession. This semi-structured interview began with a series of central and preliminary questions, but enabled new questions to form in response to responses to the preliminary questions. Abandoning the constraint of pre-established questions with expected answers, I opted for a semi-structured interview for the same reason I chose a survey with a majority of anecdotal responses—to allow the participant to respond in a way that is more free and true to their perspective or ideas. This interview consisted of an email thread in which I asked various questions about their work, and trends they saw in their process of making scientific findings available to the public (See Appendix 13).

Data Analysis

Rather than code for patterns or create word clouds which are more efficient and appropriate for more numerous responses or larger texts, like the surveys and documents, I spent time with each answer and sought out overarching patterns that fit within my thesis as a whole. Because this component of my data analysis was just one person, I was able to tackle each response thoroughly and carefully.

Goal

I sought this perspective from the interview, because I wanted to know what regulations and standards existed to transform data and numbers into concepts that the public could interpret as facts. I also wanted to know what it was like to translate documents into the colloquial in general. This interview also prepared me for my own original translation.

Original Translation

After collecting this moderately diverse data, I also created my own translation of the document that I gave to survey participants to read. In the translation, I took what I learned from my research, from my data collections, surveys, and my informal interviews and tried to eliminate jargon, plastic words, and metaphor from a key invasive species text. I provided each step of this process to show what is lost and what is gained in this translation. If this project is to be replicated, one should undertake this activity after all other data is collected and analyzed.

Goal

I wanted to know what it is like to eliminate plastic words, jargon and metaphor from the discourse of invasive species management.

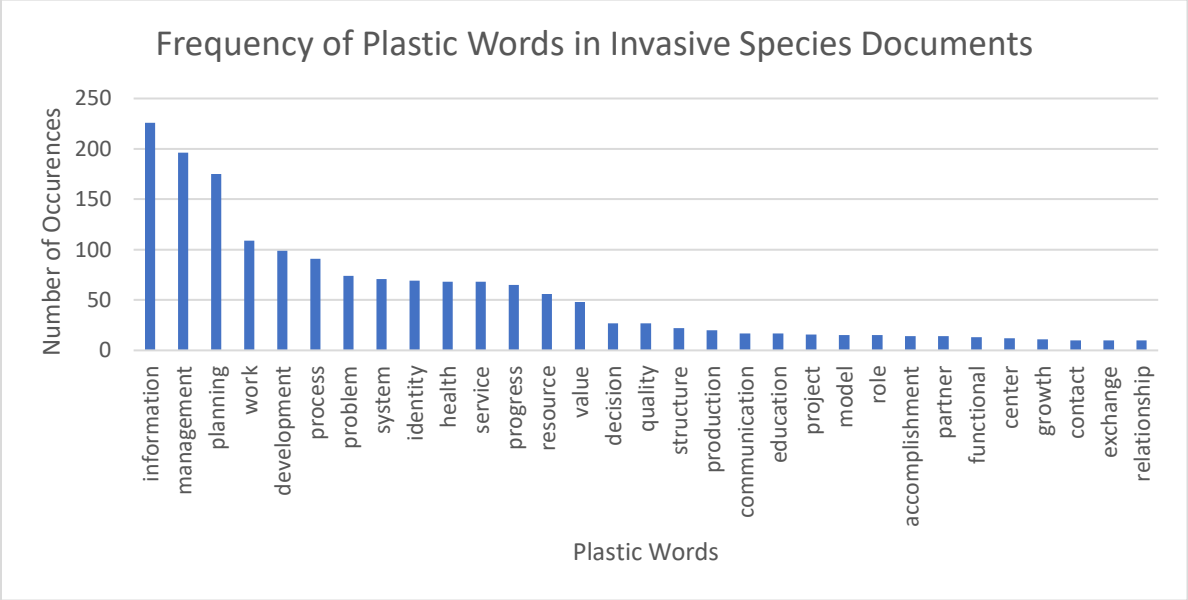
Chapter 4: Results & Analysis.

My research question is many-layered and requires multiple modes of data extraction and analysis to engage with. My question is not necessarily one that can be definitively answered. Rather, I approach it as an active and ongoing engagement or conversation. In order to continue this conversation, I have employed a variety of methods of data collection and analysis, quantitative, qualitative and humanist. The following data results explore how often plastic words occur in seminal invasive species texts (and therefore how much these texts rely on plastic words), and how easy or difficult it is for a variety of respondents to understand and read a certain seminal invasive species text, and why. I interpret from these data and results how words like plastic words can infect a document and what the consequences of this infection are.

Invasive Species Documents

Figure 5 shows the frequency of Poersken's plastic words in these 6 invasive species documents. I eliminated the plastic words that occurred less than ten times.

Figure 6 Frequency of Plastic Words in Invasive Species Documents



31 of the 46, or 67%, of plastic words occurred more than 10 times. 13 of the 46 plastic words occur more than 50 times. As Figure 5 shows, the most frequently occurring plastic words are “information”, “management”, and “planning”. Figure 5 shows that plastic words have a significant presence in these documents, which will be further illustrated in the following Figures.

Figure 7 Percentage of Plastic Words in Invasive Species Document

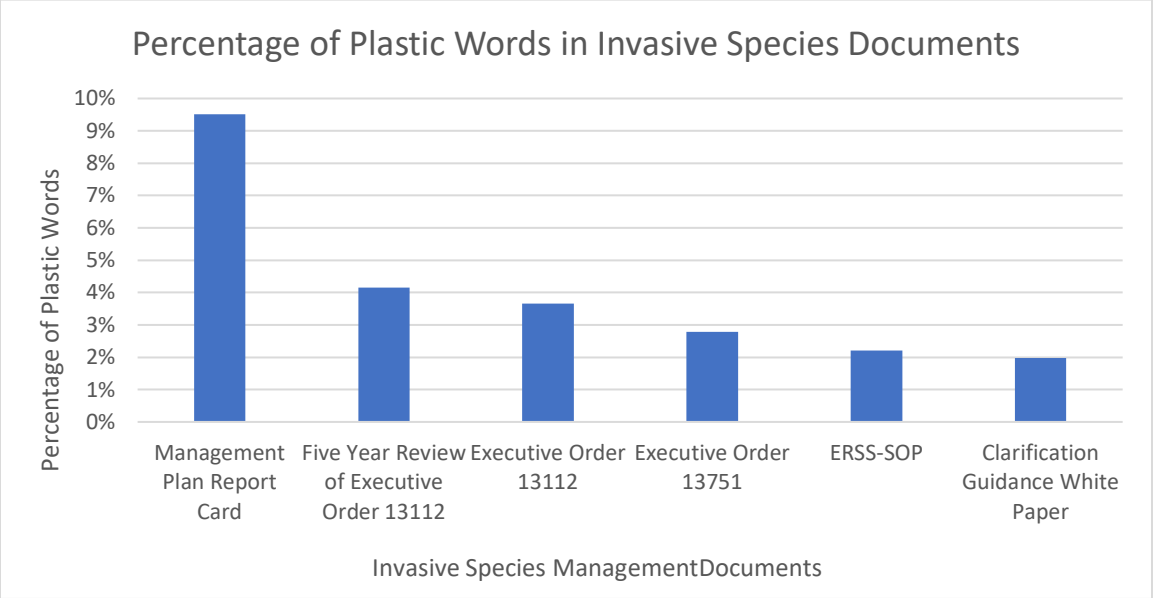
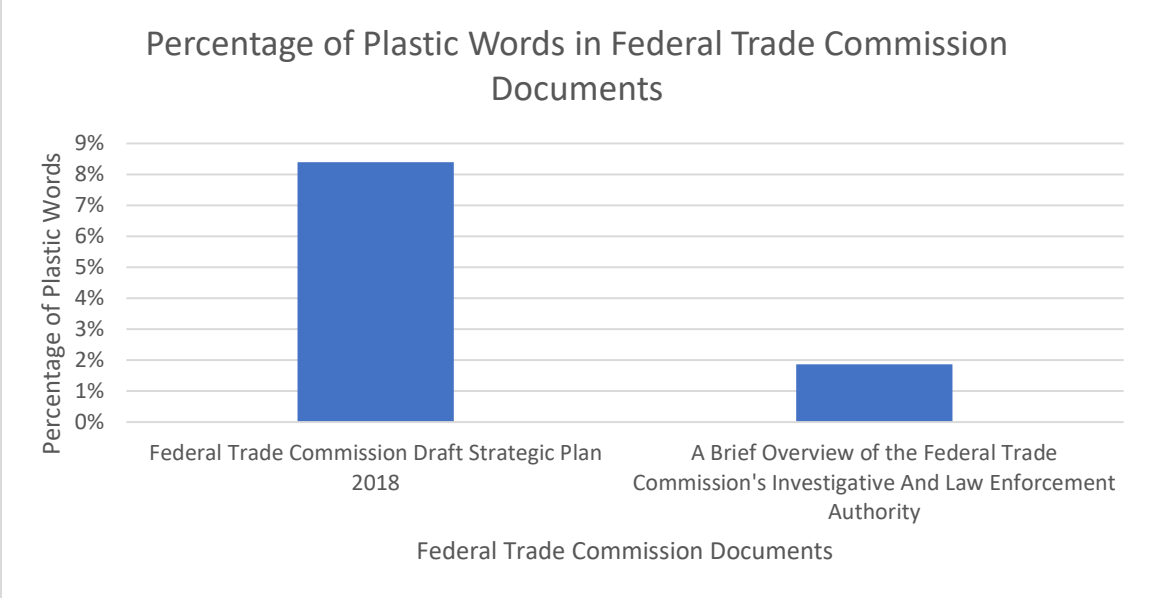


Figure 6 depicts percentage of plastic words in each invasive species document—what percentage of the document is made up of plastic words. The Management Plan Report Card clearly has the highest proportion of plastic words. The Management Plan Report Card, which has two plastic words in the title alone and is a comparably short document of three pages. It functions as a brief outline of how to control invasive for invasive species. The prominence of plastic words in this particular document suggest that invasive species management relies on as few words as possible to communicate quickly a plan for course of action but we must ask, does clarity and comprehension get lost in this brevity?

For comparison, I found two comparable documents in the discipline of economics for which I conducted an analysis to determine propensity of plastic words. Figure 7 depicts this propensity (See Appendix 9 and 10 for Full Documents). More

plastic words can be found in the Federal Trade Commission Draft Strategic Plan (2017) than in A Brief Overview of Federal Trade Commission's Investigative Law Enforcement Authority, but percentage of plastic words in these documents is comparable to percentages of plastic words in invasive species management documents.

Figure 8 Percentage of Plastic Words in Federal Trade Commission Documents



Most Frequently Used Words Depicted in Word Clouds

To see the types of words used most frequently in these documents, I created a word cloud in Atlas.ti for each document. Limits to word clouds are described in my Methods section. I added to the afore mentioned list of eliminated words several letters and punctuation marks that would disrupt the word cloud and provide skewed data.

Figure 9: Word Cloud for E.O. 13112

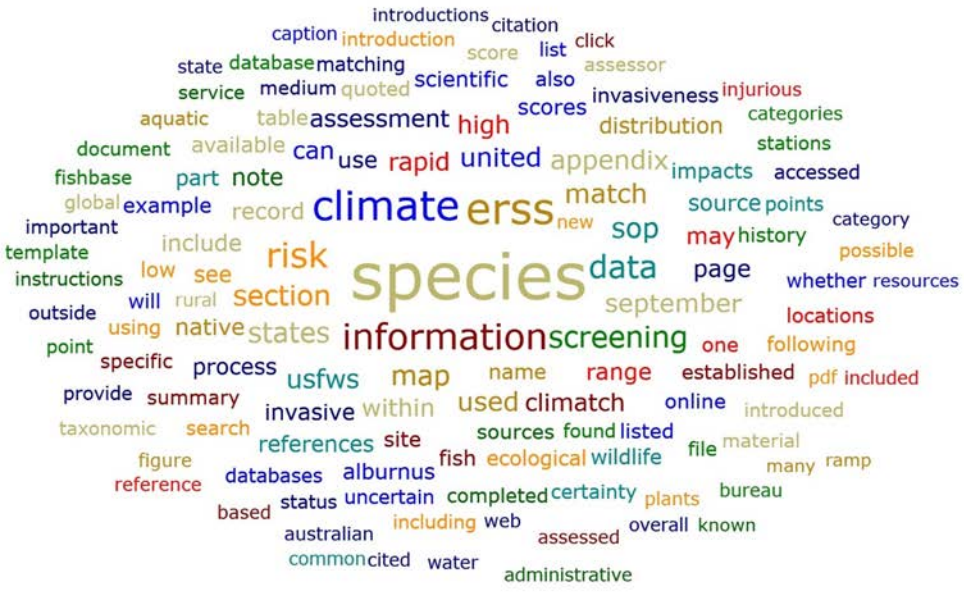


Figure 10 Word Cloud for ERSS-SOP

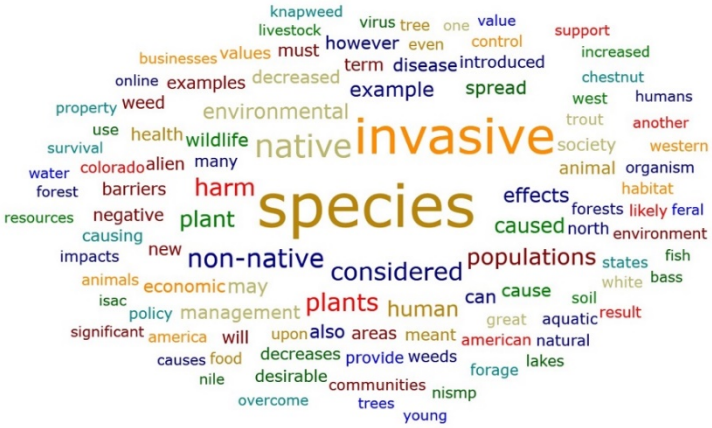


Figure 11 Word Cloud for Clarification Guidance White Paper Document

Figure 12 Word Cloud for Management Plan Report Card

Figure 13 Word Cloud for E.O. 13751

Figure 14 Word Cloud for Five-Year Review of E.O. 13112

Table 3 provides the number of word clouds (out of the six word clouds) a given plastic word appears.

Table 3 Frequency of plastic words in the word clouds for the six documents displayed in Figures 8-13

Plastic Words	**Frequency of Occurrence in Word Clouds**
Issue	1
Problem	1
Services	1
Strategy	1
Communication	1
Value	1
Develop	1
Research	1
Plan	3
Progress	2
Health	3

Plastic Words	Frequency of Occurrence in Word Clouds
Process	3
Information	4
Management	5
Resource	5

Each document's word cloud has at least three plastic words and at most eight, meaning plastic words were frequently used in each document. These word clouds further suggest that these invasive species documents do rely on plastic words to a significant degree to explain invasive species and invasive species management to the public.

Surveys

The surveys were designed to reveal any effects of plastic words in read-difficulty of invasive species documents. Read-difficulty here means how easy or difficult it was to read and comprehend the text. I read the survey responses, seeking out patterns within responses. I noticed in Mechanical Turk Survey Cohort, that there were a number of inauthentic responses that were either gibberish, irrelevant, or word-for-word copies of another response. Both the Mechanical Turk Survey Cohort and Purposive Survey Cohort had incentive to complete the survey. While no Purposive Survey Cohort respondent repeated the survey for an extra reward, I did have to eliminate 25% of Mechanical Turk Cohort's responses because monetary incentive seemed to drive individuals to take the survey multiple times.

I categorized the preamble into sections where teal represents a section dealing with definitions of invasive species, purple refers to difficulty with defining invasive species, dark green refers to a specific example, light green refers to purpose and

intended consequence of the paper, and the two light brown sections are, I think, one sentence summaries of the general purpose of the paper. Each of these sections deal with an overarching theme of definition. This paper is intended to define invasive species, while considering how it is hard to define invasive species.

The sections in yellow, light blue and grey do not deal with the overarching theme of definition. The yellow section is mostly defined acronyms, and references to other documents not present. The light blue section refers to revisions of the action plan that rely on comments from the public. The grey section refers to how a non-native species must first undergo a risk/benefit analysis to be subject to regulatory action (ie: eradication, or preventative measures) as an invasive species. Table 4 relays what percentage each sections takes up of the preamble.

Preamble: Executive Order 13112 – defines an invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." In the Executive Summary of the National Invasive Species Management Plan (NISMP) the term invasive species is further clarified and defined as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." To provide guidance for the development and implementation of the NISMP, the National Invasive Species Council (NISC) and the Invasive Species Advisory Committee (ISAC) adopted a set of principles outlined in Appendix 6 of the NISMP. Guiding Principle #1 provides additional context for defining the term invasive species and states "many alien species are non-invasive and support human livelihoods or a preferred quality of life." However, some alien species (non-native will be used in this white paper because it is more descriptive than alien), for example West Nile virus, are considered invasive and undesirable by virtually everyone. Other non-native species are not as easily characterized. For example, some nonnative species are considered harmful, and therefore, invasive by some sectors of our society while others consider them beneficial. This discontinuity is reflective of the different value systems operating in our free society, and contributes to the complexity of defining the term invasive species. NISC is engaged in evaluating and updating the 2001 NISMP and is developing comments for a revised action plan as required by the EO 13112. While there have been numerous attempts to clarify the term invasive species, there continues to be uncertainty concerning the

use and perceived meaning of the term, and consequently over the prospective scope of actions proposed in the NISMP. Options related to private property use, pet ownership, agriculture, horticulture, and aquaculture enterprises may be affected depending upon the definition, use, and policy implications of the term. In particular, the desire to consider a non-native species as 'invasive' may trigger a risk/benefit assessment process to determine whether regulatory action is warranted. All these uncertainties have stood and could continue to stand in the way of progress in actions and policy development to prevent new invasions and manage existing invasive species. While it is not the purpose of this white paper to define a risk/benefit assessment process, development of such a process must be open and efficient to minimize the uncertainties. This white paper is intended to provide a non-regulatory policy interpretation of the term invasive species by identifying what is meant, and just as important, what is not meant by the term. ISAC recognizes that biological and ecological definitions will not precisely apply to regulatory definitions. We believe, however, that our clarification will apply to all taxa of invasive species in all habitats and furthermore, our explanation will be functional and acceptable to most stakeholders. ISAC simply wants to clarify what is meant and what is not meant by the term invasive species in the technical sense and to provide insight into those areas where societal judgments will be necessary to implement effective public policy. The utility of our clarification should be in education, conflict resolution, and efficiency in the planning, prevention, control/eradication, and management of invasive species (ISAC, 2016).

Table 4 Preamble's Section Percentages

Section Genre	Percentage of 542 Words
Define	20%
Difficulty	30%
Example	5%
Purpose-General	15%
Purpose-Summary	13%
Acronyms	7%
Misc1	5%
Misc2	4%

Worth noting in Table 4 is that sections that deal with defining invasive species, and sections that deal with difficulty of defining invasive species account for exactly half of this preamble.

Figure 15 Word Cloud for Preamble to Clarification Guidance Document

This word cloud describes most frequently used words in the preamble. In this word cloud, note that five plastic words occur: *development, process, plan, health* and *management*. I use this word cloud and the above chart as comparison for some of the following survey questions.

Question 1. On a scale of 1-10 where 1 stands for not very familiar and 10 stands for very familiar, how familiar are you with the way invasive species are talked about?

Purposive Survey Cohort

For the Purposive Survey Cohort, there was a range of 4-10 for how familiar participants were with how invasive species are talked about. On average, participants had a familiarity of 8.12, while a level of 8 was the most repeated level of familiarity.

Mechanical Turk Cohort

Mechanical Turk Survey Cohort had a wide range of 1-10 for how familiar they were with how invasive species are talked about. On average, participants had a 5.58 level of familiarity, and 8 was the most repeated level of familiarity.

Comparing the average level of familiarity between the two groups, these numbers appear to suggest that the Purposive Survey Cohort was more educated and cognizant of the kind of academic language in the preamble, while the Mechanical Turk Survey Cohort was less educated. The Mechanical Turk Survey Cohort had a wider range of familiarity than did the Mechanical Turk Survey Cohort.

I performed a 2 tailed t-test allowing for unequal variances and got a p-value of .000099 which is less than .05 suggesting a statistical significance. This indicates that there is a strong difference of familiarity with invasive species language between the two cohorts.

Question 2. On a scale of 1-10 where 1 stands for very easy and 10 stands for very difficult, how easy or difficult was it for you to read and understand this document?

Purposive Survey Cohort

The range of read-difficulty for the Purposive Survey Cohort was 1-9. On average, participants found the document a level of 5.54 for read-difficulty meaning it was neither too difficult nor too easy to understand, while most repeated level of read-difficulty was 8, meaning it was more difficult to understand. While many people responded to the former question with an affirmation that suggested they were very familiar with how invasive species were talked about, many respondents had considerable, above average difficulty reading and understanding the document. Unfortunately, I believe some of my respondents did not read these first two questions carefully enough, and were confused about which extremes 1 and 10 referred to. For example, one participant said they were 10/10 very familiar with how invasive species were talked about but put that the document was 9/10 very difficult to understand. Nine participants said they were familiar to very familiar (6-10) with how invasive species are talked about but also said the document was difficult to very difficult (6-10) to understand. These seem like discrepancies to me, but may also reflect how difficult to read the document was, despite familiarity.

Mechanical Turk Cohort

Mechanical Turk Cohort Participants responded with a range of 1-10 with an average of 6.77 and a mode of 8. Participants expressed similar discrepancies between responses for the first two questions of knowing about how invasive species are talked about and comprehension of document. Participant 1 said they had an 8/10 level of

familiarity and an 8/10 level of difficulty. Participant 2 said they had a 2/10 level of familiarity and 3/10 level of difficulty difficulty. Participant 59 said they had a 4/10 level of difficulty but responded to question 8— “Explain what you think is being said in this document?”—with “I don’t know at all”.

The following Figures, Figure 15 and Figure 16 depict correlation between read-difficulty and familiarity for the Purposive Survey Cohort and the Mechanical Turk Survey Cohort.

Figure 16 Purposive Survey Correlation

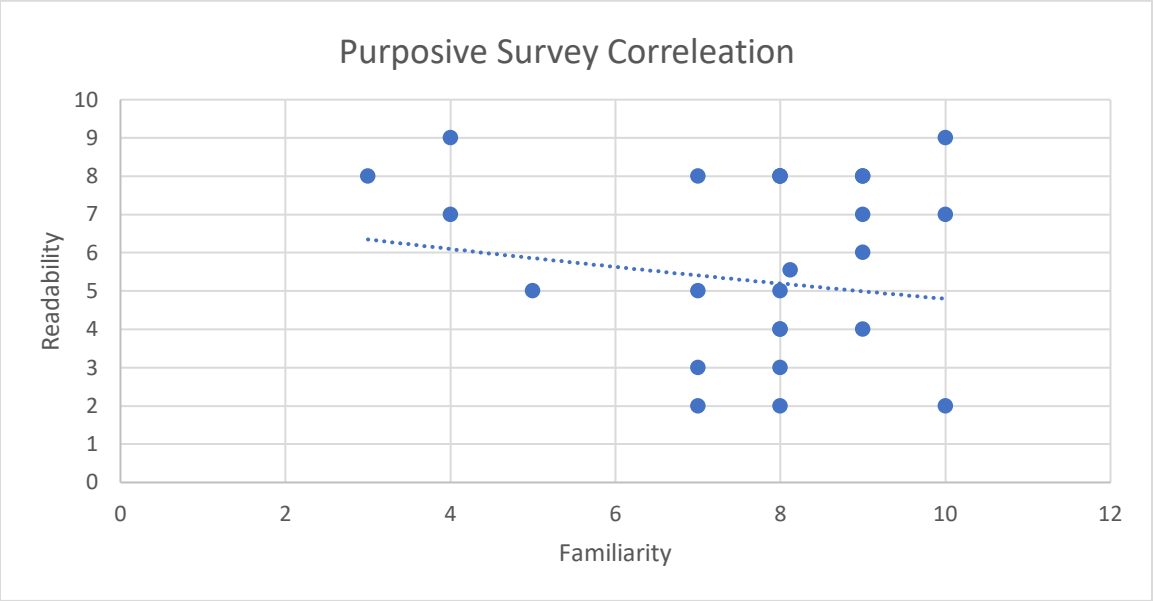
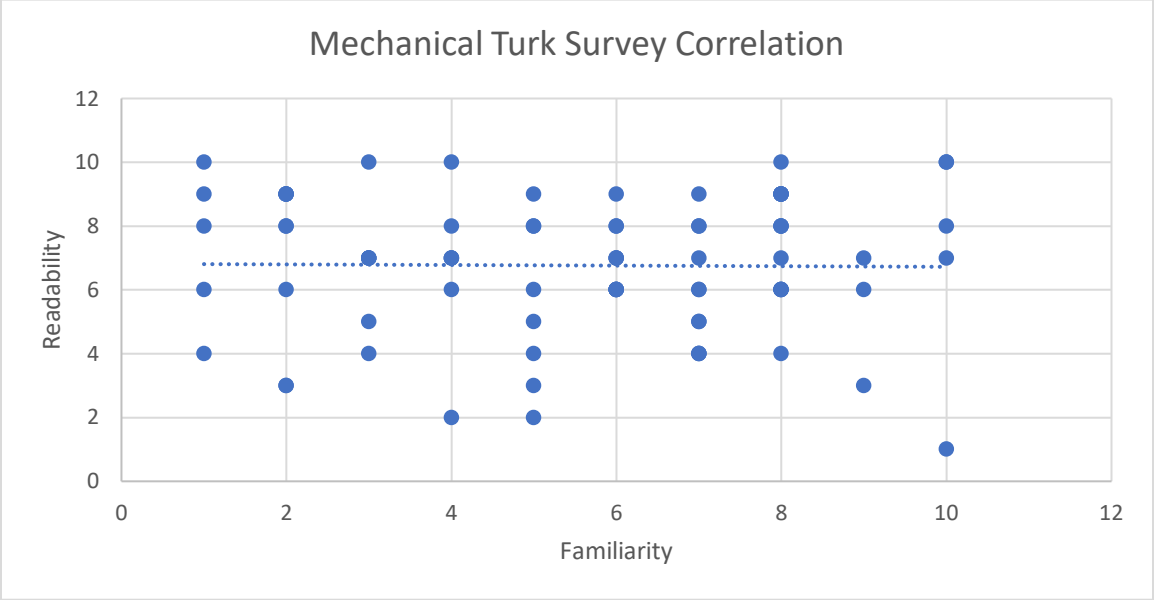


Figure 17 Mechanical Turk Survey Correlation



For the Purposive Survey Cohort, there was a negative correlation between read-difficulty and familiarity, which suggests the more familiar with the way species are spoken of, the more readable the document was, and for the Mechanical Turk Survey Cohort, there was no correlation between read-difficulty and familiarity. The anticipated correlation—that the more familiar participants are with how invasive species are talked about, the more readable the preamble will be for participants—is extant in the Purposive Survey Cohort, but not in Mechanical Turk Survey Cohort.

I performed a 2 tailed t-test allowing for unequal variances for both cohorts and got a p-value of .042 which is less than .05 suggesting statistical significance. This indicates that there is a strong difference of read-difficulty for the invasive species document between both cohorts.

Question 3. Which sections or sentences in this document are easiest to understand? Copy and paste portions here.

The following Table, Table 5, shows what percentage of survey responses includes a portion of the document that corresponded with the sections I have defined.

Table 5 Easiest Section Genre to understand by percentage in responses

Section Genre	Percentage of Subjects Purposive Survey (N =24)	Percentage of Subjects Mechanical Turk (N=79)
Define	42%	54%
Difficulty	46%	35%
Example	38%	14%
Purpose-General	33%	15%
Purpose-Summary	29%	15%
Acronyms	8%	5%
Misc1	8%	1%
Misc2	4%	6%

There were a divergent range of responses for this question. Of the Purposive Survey Cohort, two participants responded that “the entirety” or “all” of the document was easy to understand, while one participant responded that “The whole document was very difficult to digest. I had to read it through at least 5 times”. For both Purposive Survey participants and Mechanical Turk participants, sections that dealt with definitions and sections that dealt with difficulty of definitions were generally most easy to understand. Because both of these section genres combine to make up half the preamble, it would

logically follow that many responses would include these sections. However, 36% of Purposive Survey Cohort responses and 14% of Mechanical Turk Survey Cohort responses included sections with an example as easier to understand. One participant in the Purposive Survey Cohort simply stated: “Sections that provide specific examples” as sections that were easiest to understand. Given that the section which includes an example made up only 5% of the entire document, it seems that ease of comprehension is reinforced through examples or stories. In general, however, Purposive Survey Cohort responses and Mechanical Turk Survey Cohort responses did not have much more overlap of what sections participants found easiest to understand.

Question 4. Which sections or sentences of this document are most difficult to understand? Copy and paste portions here.

The following Table, Table 6 shows what percentage of survey responses includes a portion of the document that corresponded with the sections I have defined.

Table 6 Most difficult Section Genre to understand by percentage in responses

Section Genre	Percentage of Subjects Purposive Survey (N =24)	Percentage of Subjects Mechanical Turk (N=79)
Define	33%	10%
Difficulty	58%	39%
Example	21%	3%
Purpose-General	29%	27%
Purpose-Summary	8%	17%

Section Genre	Percentage of Subjects Purposive Survey (N =24)	Percentage of Subjects Mechanical Turk (N=79)
Acronyms	25%	11%
Misc1	13%	28%
Misc2	25%	8%

In responses to this question, two Purposive Survey Cohort participants said "N/A" and one participant said that they "didn't find anything particularly difficult to understand". In the Purposive Survey Cohort, 58% of responses included a section that discussed the difficulties in defining, which is interesting, because 46% of responses from the same cohort included difficulties in defining sections as *easy* to understand. Similarly, in the Purposive Survey Cohort, the next highest number of responses, 33%, answered that sections dealing with definition were difficult to understand, but 42% of Purposive Survey Cohort responses also suggested that this section *easier* to understand. A similar unexpected discrepancy occurred in Mechanical Turk Survey Cohort responses. The section that dealt with difficulties in defining occurred in 39% of responses arguing that it was hard to understand, but 35% of responses suggested these sections were *easier* to understand. In general, responses for what sections were most difficult to understand differed greatly between Purposive Survey Cohort responses and Mechanical Turk Cohort responses, and for both Cohorts, certain sections were considered both easy and difficult to understand.

Question 5. List 3 to 5 words or phrases used in this document that are easier to understand or otherwise straight-forward. (You may choose words or phrases from your answer to question number 3).

I generated word clouds from participant responses. They do not follow the same threshold as word clouds for invasive species documents—instead I allow for all frequently used word to appear with the exception of the excluded word list.

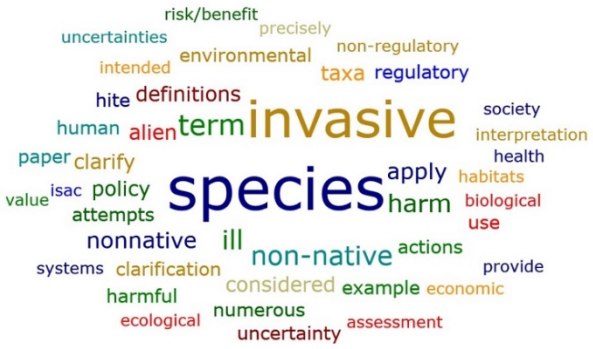


Figure 18 Word Cloud for Purposive Survey Cohort Easiest Words

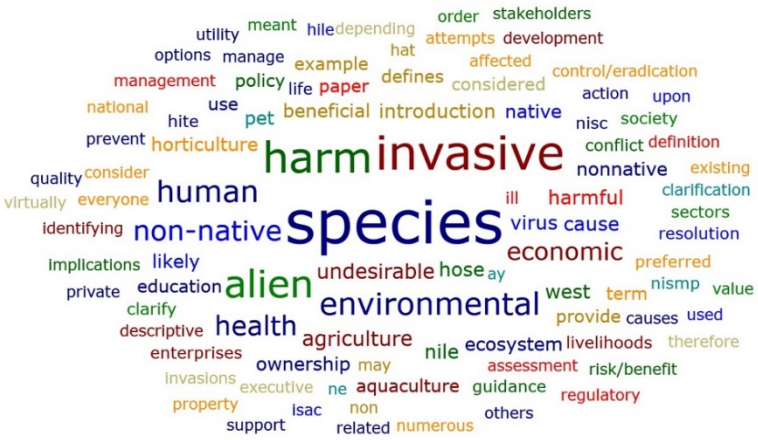


Figure 19 Word Cloud for Mechanical Turk Cohort Easiest Words

Figure 15 includes two plastic words: *health* and *value*. Figure 16 includes five plastic words: *health, education, development, management* and *value*. This is unsurprising because a characteristic of plastic words is that they are familiar to most people and most people have an idea of what they mean. These word clouds look similar; there is overlap of easiest words to understand between the two groups.

Question 6. List 3 to 5 words or phrases used in the document that are more difficult to understand or otherwise confusing. (You may choose words or phrases from your answer to question number 4).

Figure 20 Word Cloud for Purposive Survey Cohort Hardest Words

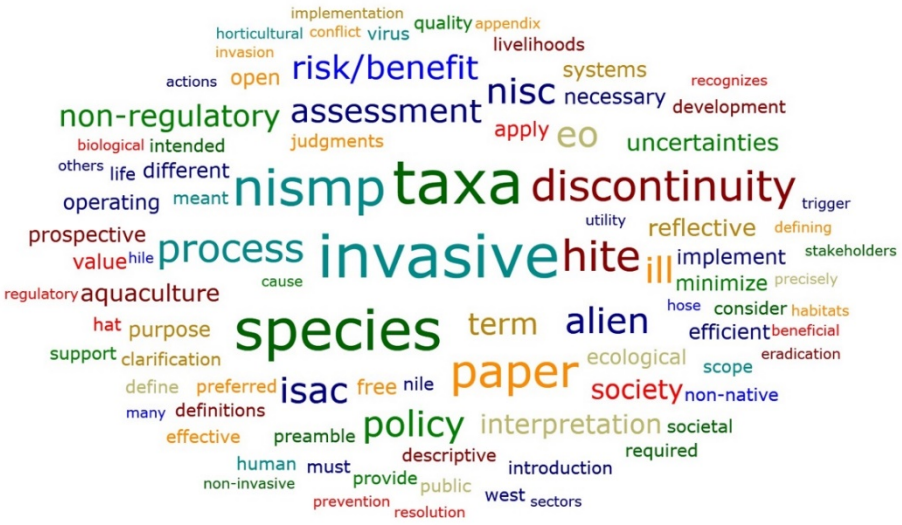


Figure 21 Word Cloud for Mechanical Turk Cohort Hardest Words

For both the Purposive Survey Cohort and the Mechanical Turk Cohort, many of the responses included acronyms and references to papers that were not clearly defined in this document as being a source of confusion. *Risk/Benefit* appeared multiple times, as did *taxa*. Other phrases that seemed most difficult to comprehend included: *development, implementation, non-regulatory policy interpretation,* and *prospective scope*. One response in the Purposive Survey Cohort in particular grabbed my attention. This participant wrote that "none of the vocabulary words were very difficult for me to understand, but these could possibly have multiple contexts/meanings"[2]. The words this participant was confused about were ones whose meanings were variable. This is a clear

[2] This response came after I performed the coding for questions 1-4 and so could not be included in that data analysis.

characteristic of plastic words, and yet this participant did not choose any plastic words as being difficult to understand. The list of words they chose as difficult to understand were “risk/benefit assessment, regulatory, invasive”. Easiest and hardest word clouds for the Purposive Survey Cohort look very similar. Invasive species is both easy and hard to understand for both the Purposive Survey Cohort and the Mechanical Turk Survey Cohort.

Question 7. Define what you think the words or phrases you chose for question 6 mean.

For both Purposive Survey Cohort and the Mechanical Turk Survey Cohort, there were many responses that indicated doubt and confusion, and several responses that seemed to be questioning the narrative of the document. When I say “questioning the narrative” I mean that these responses express critical opinions about the document, its language or the authors or scientists who wrote the document.

Purposive Survey Cohort

Confusion

Participants largely formed clear definitions for the words they were confused about, but sometimes while acknowledging their doubt. The patterns I’ve noticed in responses include characters or words that suggest confusion or uncertainty, such as “?”, “I think” “a guess”, etc. 33% of participants expressed doubt and confusion.

Participant 1 wrote: “took me a second”, and “a guess”. Participant 4 defined two words but for the third responded with a question mark “?”. Participant 5 acknowledged confusion in the document. Participant 6, in response to confusion regarding the term “risk/benefit”, wrote “but for whom? and what?” and also included a question mark “?”

after a definition they created for “regulatory action”. Participant 10 wrote “I imagine” and “I think?” while explaining confusing words. Participant 11 included a question mark “?” and “it looks like” in an explanation. Participant 19 wrote “I do not know”. Participant 20 said the text was unclear.

Questioning the Narrative

The following responses included opinion about the document’s clarity, in addition to definitions. Participant 5’s response explains that while the words were not difficult to understand, the structure of the document and overuse of passive voice made it difficult to read the document. Participant 6’s response “but for whom? and what?” suggests, I think, a critical curiosity of who gets to define risks and benefits. Participant 20 similarly explained their perspective on where the confusion in this document might be. They focused on these sentences as being the most unclear:

> The utility of our clarification should be in education, conflict resolution, and efficiency in the planning, prevention, control/eradication, and management of invasive species. This white paper is intended to provide a non-regulatory policy interpretation of the term invasive species by identifying what is meant, and just as important, what is not meant by the term. ISAC recognizes that biological and ecological definitions will not precisely apply to regulatory definitions.

They argued that while the sentence may be straightforward, nuances and implications are unclear. They wrote that: “there is no explanation as to what sources that clarification will be based on” and that “the word ‘interpretation’ is disconcerting”.

Participant 17 considered the difficulty in defining the term invasive was simply a loophole created by scientists to avoid having to act in a determinable way.

Mechanical Turk Cohort

Confusion

Patterns I noticed from the Mechanical Turk Cohort responses again included general confusion and self-doubt when trying to define confusing terminology or sections. Twenty-nine responses, or 36%, suggest confusion. General indications of confusion include “I think”, “I don’t know” or “I do not know”, “Not sure”, “No idea”, “Not exactly sure”, “not sure”, “not familiar”, “may be”, “guess”, “not familiar” or “?”. Participant 10 wrote: “looks like” and participant 20 wrote “sounds like” when trying to explain a certain definition. Participant 11 wrote “maybe”. Participant 14 wrote flat out “I don’t even know!”, referring to taxa, stakeholders and ISAC. Participants 14, 16, 22, 24, 30, 37, 40, 61, wrote variations of “I have no idea”. Participant 19, 46, 67, 69 and 71 included a question mark “?” following the definitions they formed. Participant 46 also mentioned the document “could have been explained better” In response to risk/benefit, participant 21 wrote that they didn’t know “what they mean in this context/what they entail”. Participant 34 wrote they were unsure what a certain regulation was for. Participant 36 included the phrase “probably means”. Three participants (26, 44 and 75) wrote that the words used were jargon, that sentences were confusing, or that they weren’t grasping how the words were being used in this context. Participant 38 explained that unfamiliar terms were hard to remember while reading. Participant 39 said they didn’t understand something in their explanation. Participant 47 wrote “I think”. Participants 55 and 56 wrote they were just too unfamiliar with the terms to understand the document clearly. Participant 58 wrote “I do not know”. Participant 76 wrote that the words had shallow meanings.

Questioning the Narrative

Commentaries on and critique of the document also appeared in responses. Participant 46 said that the document could have been explained better. Participant 20 wrote that "it sounds like obscure bureaucratic paperwork" and that they were familiar at least with that type of jargon because they work for the United States Postal Service. Participant 26 explained that the words they chose as confusing were "a bunch of jargon" which they were "unfamiliar with", and which seemed "too technical". The words they chose include: "Appendix, implementation, EO, advisory". Participant 25 chose "…is intended to provide a non-regulatory policy interpretation of the term invasive species" as one of the most confusing phrases and wrote that it meant that "the objective is to provide an unofficial definition of "invasive species" but was confused why an unofficial definition would be useful. Participant 39 didn't understand what preferred quality of life referred to—specifically whose gets to decide what the preferred quality of life is. Participant 54 explained that they knew what the words meant individually, but that these words were picked specifically to prevent a "clear and direct point does not need to be made". They, too, questioned who gets decide what the "most 'efficient' way to come to a conclusion" and they wondered exactly "whose 'uncertainties' about the process need to be minimized?"

Aliens

Some participants, for whom English may not be first language, literally thought the word “alien” referred to extra-terrestrials, and believed this document meant that invasive species were from outer space. This becomes clearer in further responses. Participant 71, for example interpreted from the document that “aliens are human friends” and can “offer us a better life”, concluding with a question mark “?”. Participant 7 believed that “risk assessment of aliens will be done”.

Question 8. Briefly summarize what you think is being said in this paragraph.

Purposive Survey Cohort

Participants largely agreed that the paper was about difficulties in defining invasive species, and that the document is designed for clarification. The responses were summaries for the most part, but several respondents described anecdotally issues they had with the paper or offered suggestions for improvement.

Questioning the Narrative

Participant 2, following up their summary, writes that “it’s not clear what they are proposing, why a change is needed, or what value the white paper offers to the reader”. Participant 11 added to their summary that “many of the words that were easy to understand… became more difficult to understand when they were all used in the same sentence, or used interchangeably”. Participant 13 included this scathing criticism, that the document was “long, poorly constructed and with run-on sentences” before summarizing. Participant 23 criticized this summary as human centric – criticizing that

invasiveness is determined partly on scientific data and partly on society's "fickle whims".

Mechanical Turk Cohort

Most participants responded with believing that the document is about trying to clarify the term invasive species.

Confusion

There were three responses, from participants 50, 59 and 61 who used phrases synonymous to "I don't know", "I have no clue at all", "I can't explain it". There were words suggesting self-doubt "I think" or "I believe" from participants 10 and 19. Participant 30 interpreted the document that invasive species should be protected.

Aliens

There were again several responses referring to extra-terrestrials. Participant 7, for example, wrote "it says that invasive species are the aliens who attack our land or property and claim as their own. they pose threat economically and environmentally". Participant 44 wrote about "THE FUTURE OF WORLD WHEN ALIENS WOULD INVADE AND WHAT HAPPENS TO THIS WORLD", while participant 47 summarized the document as claiming "there are aliens possibly on earth they may be harmless". Participant 57 wrote the document was "about the alien invasion to the world and council" and participant 71 wrote that "its talking about alien existence" (sic).

Question 9. Define invasive species in your own words.

Purposive Survey Cohort

Unfortunately, I realized I wanted to ask this question after 10 people had already responded. I reached out to those people and asked them to respond to my question. I received 6 responses. That plus the responses I already had come to 20 responses. Further, a response came in later. I incorporated their response as best I could, but it came after I finished analyzing and coding questions 1-4. Therefore, I incorporate their anecdotal or opinion responses and leave the others out.

Many responses suggested that an invasive species in some way caused damage/harm in general, or harm to native species and/or native ecological regions. Sometimes harm was replaced or added to that invasive species spread quickly or dominate. Participant 12 used the word "threatening" and said an invasive species would "drive down species diversity by creating a monoculture".

Questioning the Narrative

In addition to defining invasive species, participant 25 begins to question the existing narrative of invasive species, writing that "I have been curious about the ecological functions of invasive species after human disturbance, and whether they might provide essential functions that the existing native species would be pressed to provide". Participant 21 writes "Personally I think care must be taken when defining non-native species" because "global warming may create a condition where species may need to migrate on their own or with several degrees' longitude or latitude or more". Participant 22 argued that the current idea about invasive species might be outdated and human

centric, that “invasive” is “an arbitrary designation that is based on current conventions on what is considered a native from historical baseline and human interests”.

Mechanical Turk Cohort

Many participants responded bluntly, and most were direct definitions stating that they cause harm to the environment, humans, animals, or are economically harmful. Some mentioned that native species are unprepared for invasives and can’t compete with invasives. Ten Participants (10, 11, 14,15, 16, 21, 29, 50, 52, 70) saw invasives as just non-native, neglecting to mention harm. Participant 61 simply wrote “I don’t know”. Many participants wrote unfavorably of invasives, they are “bad” (13), they are “a species that destroys the environment” (3). Participant 71 saw invasives as “intruders who are not welcome”. Conversely, participant 30 interpreted the invasive species as “not harmful”. Participant 76 wrote that they saw ‘invasive’ as “just another word for something different”. One participant (20) defined invasives using the word “ecology”, but also defined what they meant by ecology as “the total organic assembly in a location… it could even be the ‘ecology’ of a tree stump”.

Examples

Three participants (11, 33, 39) provided examples of invasive species they knew about from their own experiences. One described non-native fish and weeds in Minnesota, while the other two described the effects of the Kudzu vine that “took over other plants and can lead to soil depletion” or “something that’s not native to the area that comes in and grows and takes over causing harm to people, pets, property, like the kudzu to the south”.

Aliens

Again, several participants (44, 47, 57, and 69) perceived invasives as extraterrestrials as: “FROM ANOTHER PLANET” or “Life from another source other than earth”. Participant 57 mentions “Invasion of outer world living organisms” and Participant 69 wrote they were species “unseen before on earth”.

Figure 22 Frequency of Plastic Words in Survey Responses

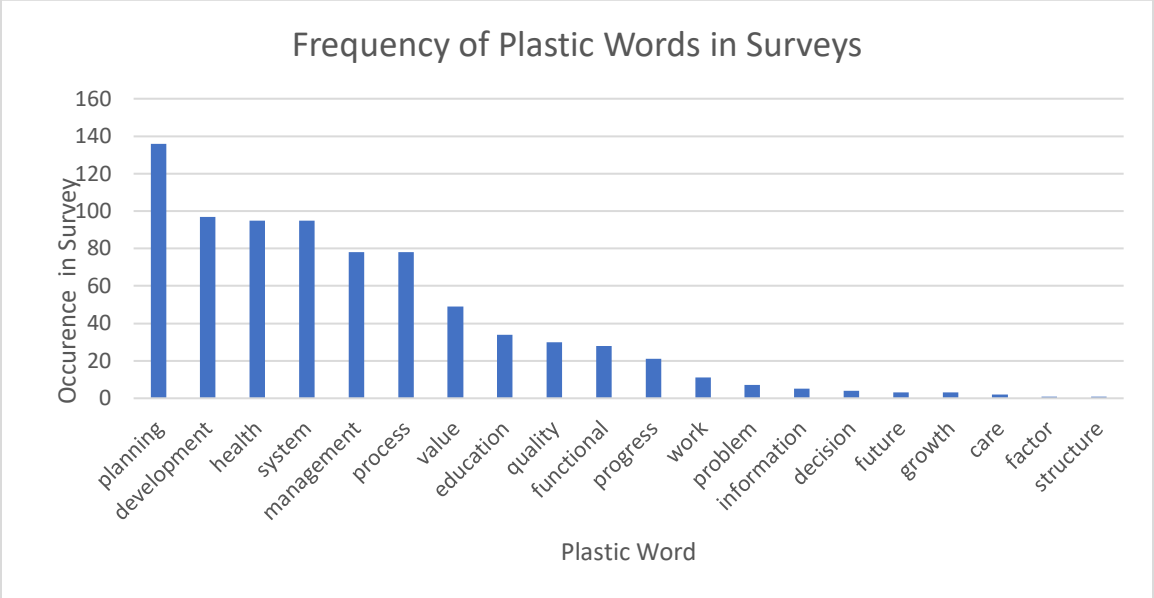
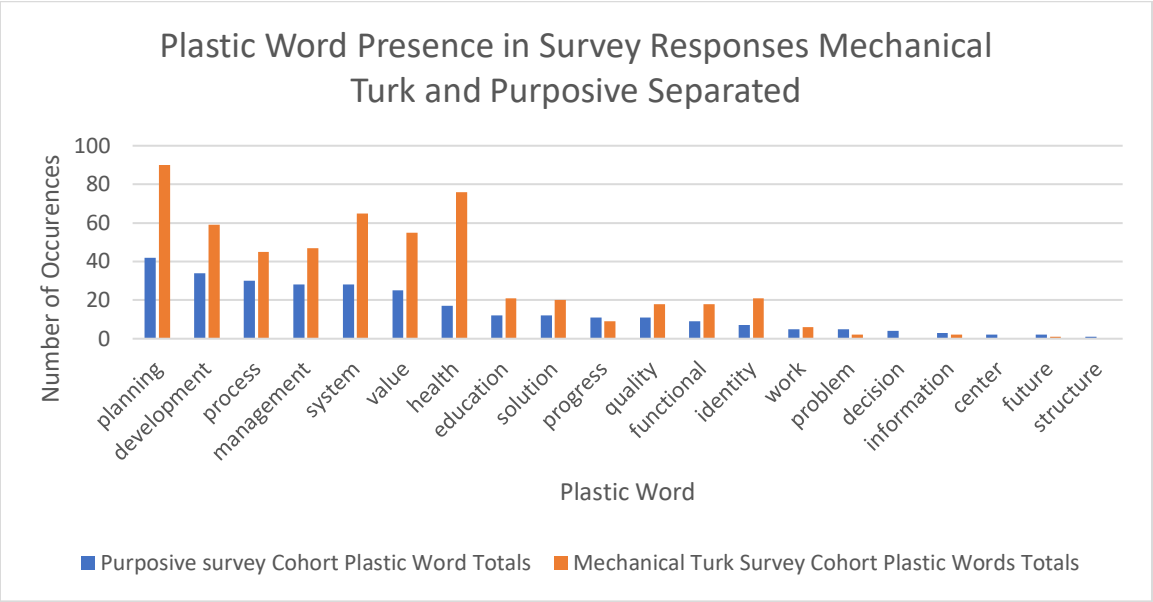


Figure 23 Frequency of Plastic Words in Mechanical Turk and Purposive Survey



In all survey responses, Figure 19 shows how often plastic words occur. “planning”, “development” and “health” occur most frequently. Figure 20 shows a comparison of presence of plastic word responses between the Purposive Survey Cohort and the Mechanical Turk Cohort. This chart shows that there are consistently more instances of plastic words in the Mechanical Turk Survey Cohort responses than in Purposive Survey Cohort responses. This may suggest that the more educated individuals in the Purposive Survey Cohort understood plastic words better but did not necessarily find them easiest to understand. The following Figures 21 and Figure 22 compare the frequency of plastic word in each short answer response for Purposive Survey Cohort and Mechanical Turk Survey Cohort.

Figure 24 Frequency of Plastic Words in Purposive Survey Cohort Responses by

Question

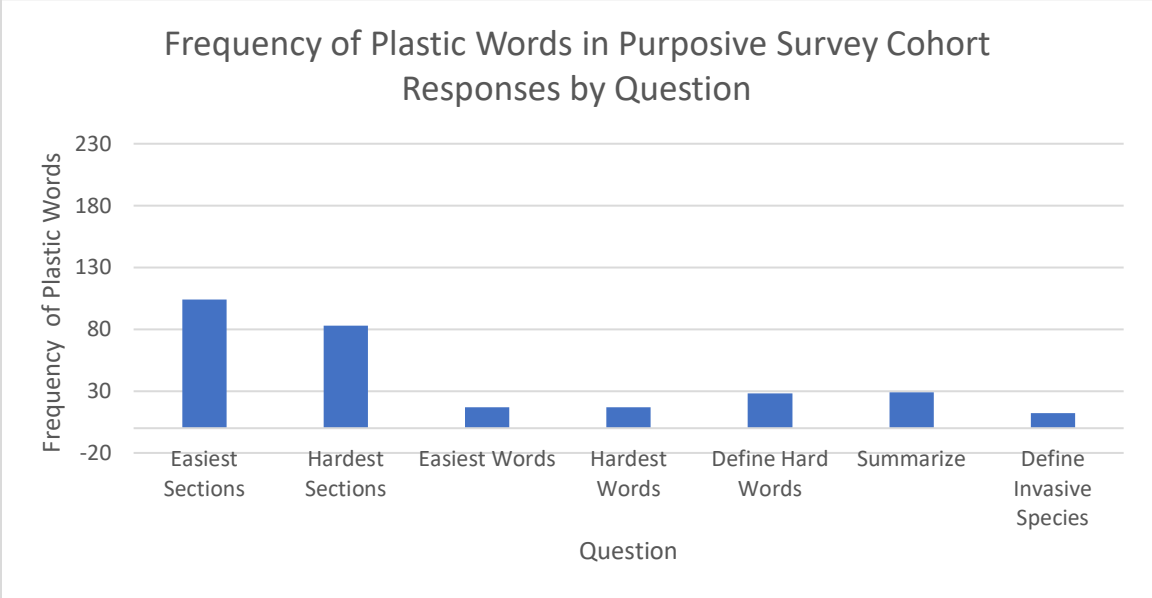
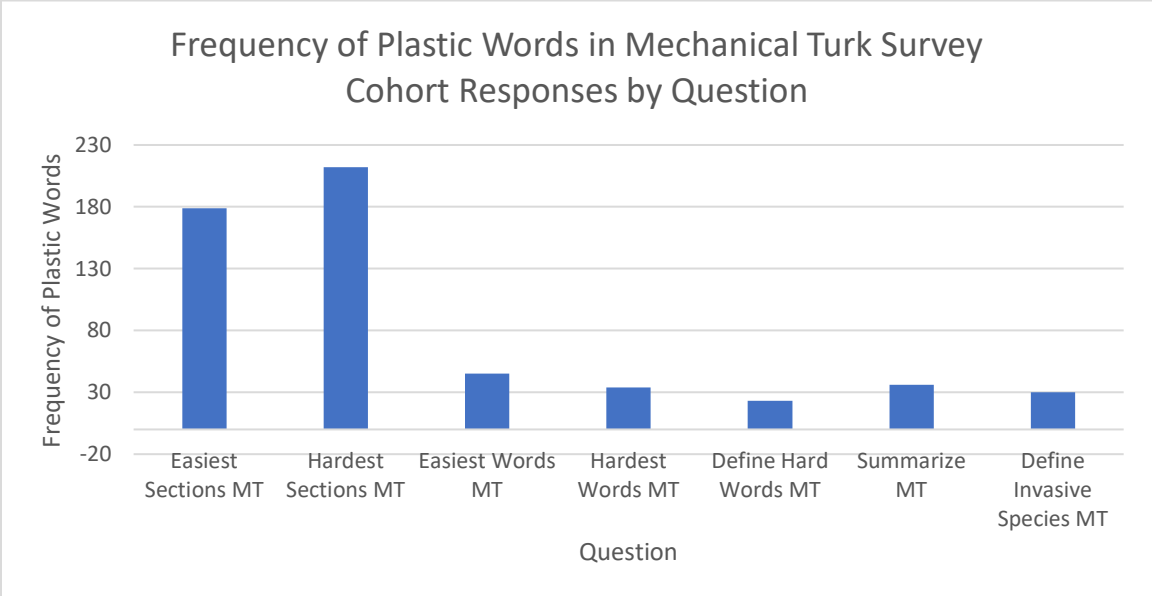


Figure 25 Frequency of Plastic Words in Mechanical Turk Survey Cohort Responses by Question



We can see that in each case there is a higher frequency of plastic words for the response to the easiest and hardest sections, but that the Mechanical Turk Cohort responses contain around double the amount of plastic words.

Interview

The interview consisted of a series of emails. The occupational role of my interviewee was to colloquialize "technical concepts, scientific objectives and engineering challenges" that revolved around their line of work. They would analyze documents and, when necessary, interviewed "subject matter experts" in order to understand more clearly the more complex data or concepts they reviewed. Then, they would synopsize and simplify the work, "aiming for a general audience". They explained that their writing was almost always addressed to the general public and the news media. In answering my question about whether there were inaccessible words, phrases or ways of explanation to be replaced, they replied that there were "many, many words, phrases and concepts" they had to replace to make the writing clearer and more easily understood. The example they include is the word "nominal" which has a different meaning within and without the context of the discipline this translator worked with. Colloquially, 'nominal' means bare-minimum requirements, but in the context of the discipline this translator worked within, nominal could be replaced "operating normally", or "operating within acceptable parameter". They went on to say "It's important to be sensitive to language usage such as this that con confuse the non-technical reader". The more difficult parts of translation were around adequately summarizing math or physics data. There was also a lot of effort that "went into critical readings of the document to

eliminate confusing statements, or language that could be easily misinterpreted". My interviewee hedged in replying to the last question of whether there were ultimately documents that did not end up feeling accessible to the audience ascribed. They explained that the range of people for whom these documents were meant could be high schoolers to "an advanced technical audience" and so the analysis in the texts could be "incredibly complex and highly technical". They occasionally needed to convey more rather than less information, sacrificing comprehension for accuracy. The executive summaries were especially important, because it is from this that most readers find their takeaways. It was important to have people who could speak easily with "public, media, government and technical community" to respond to a wide range of questions these differing bodies might pose.

Chapter 5: Discussion

Invasive Species Management Documents

As I mentioned in my Methods section, there were a handful of words that my codes picked up but which were not inherently plastic words. I had hoped to put these words and others that occurred in survey responses of confusing or difficult words through Uwe Poersken's plastic word test, however time constraints being what they are, I opted out of this part of research. Coding invasive species documents revealed a statistically significant presence of plastic words. That these documents significantly rely on plastic words to tell their story will likely have certain effects similar to those that Poersken has described and can be found in (See Appendix 1). The presence of plastic words is not surprising, nor do I believe it inherently damns the document. I have utilized plastic words extensively in this paper, and not simply because this paper deals with plastic words, but because they are omnipresent and largely inescapable. I think it is often inevitable to use plastic words, but if intention is clarity and accessibility, I think it is possible to overcome the confusion and dominating vagaries of plastic words.

Surveys

Purposive Survey Cohort

There were a few hiccups in sending out surveys and collecting responses. I came up with a question after I sent my survey out, and therefore had to ask those who already took the survey to answer the extra question. There were three participants who did not end up answering the extra question. However, written in my survey instructions I explained that I did not require participants to answer every question. There seemed to be confusion in the purposive survey of what 1 and what 10 meant. In future, I would elect

to give an example of someone who would choose 1 and someone who would choose 10. For example: Martha is an invasive species biologist. She chooses a 10 for familiarity because she works with invasives for her job. Jennifer happened to be one of the authors and wrote this document. She chose 10 for read-difficulty, because she helped write the document.

Furthermore, although I do not know exactly who responded to my purposive survey, nor the number of people it reached and so cannot give an estimated response rate. I do not think a large portion of people who received the survey ended up replying to the survey. I know for a fact that some people did not send it out to their respective affiliated groups. However, my goal was to get a wide range of respondents and to have between 8 and 20 people. For this project, the importance was the diversity of respondents, and the answers I received were widely varied.

Mechanical Turk Cohort

In the Mechanical Turk Cohort there was a high number of unusable responses (repeat surveyors, irrelevant or nonsense responses, etc.). If I were to do this project again, I would elect to select the box that asks if I want only the most elite workers to respond. Initially I wanted my survey to be generally accessible, as is the nature of this entire project. However, 24 of the 101 responses made little to no sense and were clearly the result of a worker seeking financial compensation and disregarding survey etiquette. I had to cut 25% of the responses.

Takeaways

There was a strong issue in clarity, even from those who responded that they could understand the document. This is most noticeable when comparing responses to questions 5 and 6. The section of the preamble that dealt with difficulty of defining invasive species was considered both easy to understand and difficult to understand for a significant percentage of responses in both Mechanical Turk Cohort and in the Purposive Survey Cohort. A significant percentage of Purposive Survey Cohort responses also suggested that definition sections were both easy and difficult to understand. These sorts of seemingly contradictory responses remind me of another characteristic of plastic words—that they are familiar enough that most people think they know what they mean, however when pressed it is still difficult to define these words. These sections of definition and difficulty of definition do not contain a high percentage of plastic words, but their phrasing seems to share this trademark plastic characteristic of Poersken's words. Plastic words are present in responses for questions 3 and 4. There was a visible presence of plastic words in responses, and plastic words occurred more frequently in Mechanical Turk Survey Cohort responses than in the Purposive Survey Cohort responses yet they did not occur dramatically in responses. This is not surprising, because as Poersken says of plastic words, "When they first appear, they are fashionable and command attention; but then they merge with the everyday and soon seem commonsense" (Poersken, 1999, p.1). This is the trick of them—they settle snugly into the vernacular, made familiar and we assume (until further pressed) to know what they mean or what they seem to mean. Responses suggest that the document is unclear because words are used in ways that are variable and changing, or because of grammar gone astray. Responses allude to effect of plastic words. Responses such as "I don't

know" and responses of confusion and self-doubt suggest the effect of silence. In response to question 6 which asked which words were most difficult to understand, one participant wrote: "risk/benefit assessment, regulatory, invasive (none of the vocabulary words were very difficult for me to understand, but these could possibly have multiple contexts/meanings"[3]. These words are not plastic words, but they have a few plastic characteristics. While plastic words are problematic, clarification depends not on the words themselves, but how they are used. Poersekn says of plastic words: "The effects radiate into language" (Poersken, 2004, p. 26). Poersken also explains, using his friend Ivan Illich's observation: "usage of these words colors their environment: in their vicinity other words and word groups are taken up and reditected" (Poersken, 2004, p. 59). It seems that when plastic words are used, their effects will bleed into the rest of what is being said—in this manner plastic words colonize language.

Responses also suggest that acronyms or titles that were either explained poorly or just not explained accounted for difficulty in comprehension. There were occasional inputs of opinion and criticism of the document. There were responses that questioned or challenged the narrative of invasive species, specifically who gets to write this narrative? Why do they get to decide who benefits from invasive species eradication?

Examples, anecdotes and stories make ideas clearer.

The fact that some thought that the word alien referred not to non-native species but literal extra-terrestrials suggest to me a need to clarify certain terms for those for whom English is a second language.

[3] This response came after I performed the coding for questions 1-4 and so could not be included in that data analysis.

Interview

Ultimately, while informative, my interview did not give me as many insights as I had hoped for. From their responses, I conclude that in translating from more technical to less technical, there was a variety of words to be replaced. The reason why words needed to be replaced was because they had different meanings in different contexts. Careful research went into making sure the translation of such variable words remained authentic to original technical document. There is difficulty in translating a document to be appropriate for an audience with a wide range of familiarity in how a discipline is described by experts and specialists. When translation was not possible, there exist a group of people who can easily communicate with the public to answer queries. While plastic words did not show up in responses to my questions or as examples of words that needed to be changed, the reason why certain words needed to be translated—that they vary from context to context—is a defining trait of plastic words.

Translation

After data collection, research and analysis, I began to create my own translation of the document from my survey (See Original Document in Appendix 11). In translation my intention was ultimately clarity. Ideally, this translation would be a collaboration, passed between many different people. I have replaced *invasive* with *injurious*, and have eliminated militant metaphor and plastic words (except in the case of "management" and "health" which are in organization titles and definitions, respectively).

Translation – First Attempt

Preamble—It is difficult to agree upon a definition for “Injurious Species”. We hope that by illuminating the difficulties, we can come closer to an agreed upon definition.

Key Terms: This paper uses the term injurious species instead of alien, non-native or invasive or any of the other myriad of synonyms that have been or are being used to talk about invasive species. Injurious implies the potential to cause injury. The other words have xenophobic or militaristic nuances, or are too vague or variable in meaning and do not imply the effects these particular species have.

The Executive Order 13112, written in 1999, and the Executive Summary of the National Injurious Species Management Plan have both tried to define injurious species. Their definitions are: “an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” and “a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health”. The National Injurious Species Council, alongside the Injurious Species Advisory Committee strives to keep the National Invasive Species Management Plan current and relevant, and able to adapt to change. These two groups accepted a certain set of principles in the National Injurious Species Management Plan, including Guiding Principle #1 which defines injurious species but argues also that “many alien species are non-invasive and support human livelihoods or a preferred quality of life”.

It is true that many non-native species are harmful. A clear example is West Nile virus, because it spreads rapidly and can cause death. Other non-native species are harder to define as clearly injurious. Some non-native species are considered harmful, while

others consider them beneficial. An example of this is the bathua plant in India which are considered weeds because they interfere with wheat growth but can also provide good food, and good source of Vitamin A. Because different people perceive benefit and harm in different ways, it is difficult to define any non-native species as inarguably harmful (and therefore injurious) to everyone in the region into which it has moved. The National Injurious Species Council is currently updating the National Injurious Species Management Plan based on public comments. This is required by the Executive Order 13112 which first called national attention to invasive species and created the National Injurious Species Management Plan, the Injurious Species Advisory Council and the National Injurious Species Council.

There is still confusion with how the term injurious species is used and what it means, and therefore what exactly National Injurious Species Management Plan proposes to do. Their intentions regarding use of private property, types of pets one can own, plants and animals grown in agriculture, and various local, statewide or global policies are therefore unclear. This paper intends to clarify the term injurious species, and therefore what can be expected when you might encounter actions, laws, policies etc. regarding injurious species. We, the Injurious Species Advisory Council, know the term is confusing, and biological or ecological definitions will not carry over seamlessly to regulatory definitions. We believe that the clarification in this paper should apply to any and all injurious species in any and all regions. We believe most stakeholders will accept our explanation and use it to define injurious species. By clarifying injurious species, we will also point out the areas in which clarification remains difficult and variable. We hope that our clarification will be used to tell others what injurious species are, in helping

resolve conflicts, and in dealing with extant or potential injurious species through prevention, control and eradication.

Translation – Second Attempt

Key Terms: This paper uses the term injurious species instead of alien, non-native or invasive or any of the other myriad of synonyms that have been or are being used to talk about invasive species. Injurious implies the potential to cause injury. The other words have xenophobic or militaristic nuances, or are too vague or variable in meaning and do not imply the effects these particular species have.

Injurious species are difficult to define resolutely. They are also difficult to name, going by many different names by many different people. We offer two similar and extant definitions.

First, Executive Order 13112 defines an injurious species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."

Second, the Executive Summary of the National Injurious Species Management Plan (NISMP) defines injurious species "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health."

These definitions are similar in taste, but within them lies great controversy and hypocrisy. Injurious species are affectionately called "invasive species" by most. This term is metaphorical in nature and therefore persuasive and misleading. It carries militant undertones. These species are not a militarized enemy invading, but rather a species more

often than not kidnapped and carried from region to region by anthropogenic forces, where they were inclined to survive. Their survival occasionally occurs to the detriment of native species because their sudden presence upsets a habitat that has been balancing for millennia. However, as the NISMP explains “many alien species are non-invasive and support human livelihoods or a preferred quality of life.” Injurious species are subjective; some may find injurious species harmful while others may find the same species beneficial. It is hard to come to a unanimous definition because different people benefit from different things.

There are clear examples of injurious species which are unfavorable to all, including the fatal and loathsome West Nile Virus, responsible for mass death. However, other injurious species are perceived injurious only to some, while others may reap great benefits from them. Further, a non-native species may only potentially decrease economic worth of something in order to be considered harmful. For example, bathua in India is considered a weed because it competes with the highly marketable wheat plant. It is therefore being sprayed with herbicides. Yet locals would use it for its nutritious value and its high Vitamin A content.

It is therefore difficult to concretely or unanimously define any species as just injurious, and therefore the role of the NISMP is similarly vague. The following paper hopes to clarify the term as best as possible by contemporary standards, but is and will be a living document, one open to interpretation, conversation and change. We encourage our readers to share their stories of non-native species as well as currently perceived injurious species so that we may come together to find a way to diminish those which

cause most harm, while observing those which might cause more benefits. We hope too, with the help of our readers, to discover occasion when injurious species integrate within an ecosystem in a way that does not cause great ecological harm, occasion when an ecosystem demonstrates its resilience. The injurious species that exist now are subject to change, as is our perspective of them. The common understanding of injurious species by an open and public NISMP will be illustrated in this paper, and this is the primary purpose of this paper. Because the definition of injurious species is variable and liable to change, we have done the best we can and hope to continue to do so as our perspective grows, but the definition we include and illustrate below we hope will be acceptable to most stakeholders, with the common understanding that this definition is a democratic one, for which many and all voices will, to the best of our ability, be considered and taken into account. This living definition should help inform, explain, prevent, control, and maintain injurious species.

What I Learned

The first attempt served as a translation, sentence by sentence. I sought to eliminate complicated words and terminologies, while still conveying the same message. After reading this first translation, I was unsatisfied. It still felt rigid and inaccessible and confusing despite elimination of plastic words and of metaphor. The second translation carries over the tone and message, but is not a sentence-by-sentence translation. Further it wears more stylistic elements that make it feel alive and open. It engages the reader, asks for help and participation. It is humble, but intentional. The use of “we” also, I think, will help ground the reader, and establish something common. There are real people behind this document, and their known presence gives life and connection to the words. Despite

confusion not necessarily arising specifically from Poersken's list of plastic words, the ways words are used is the source of much confusion. As I have suggested, the effects of plastic words infect the documents in which they reside. Perhaps their residue clings to my translations. I do not know. The translations are an experiment, and serve as a conversational piece, or an invitation for consideration. I cannot draw anything more solidly than my experience translating them. If I had more time, I would have sent these translations to the Purposive Survey Cohorts and the Mechanical Turk Survey Cohorts and had them complete the survey again with the new translation. Alternatively, I could have sent my translation with the survey questions to a new cohort, and then compare survey results from the original document and survey results from my translated document.

By All Means, "Call Out" That Word!

Earlier this year, I participated in a Poster Session with the rest of my MES class. In this Poster Session, we designed a poster about our thesis topic. As I stood by my poster, a student asked me a question which I thought very interesting and very important. They asked me about a word they needed to use when writing their thesis. "It seems kind of like a plastic word", they told me. "I don't think I can use any other word instead. So, what should I do if I have to use a plastic word when writing my thesis?" They agreed that plastic words were confusing and not optimal ways of communicating findings to an audience. They were essentially asking me what their responsibility was, as a scientist, when they used these sorts of confusing, slippery words. I told them that I thought, in general, that it is best to try to avoid these sorts of words. I agreed that some

of these words are unavoidable. In that case, I explained, I think it's important to "call out" these changing words that seem to avoid concrete definitions. Uwe Poersken has suggested adding a component to dictionary definitions, where a word's *slang* or *archaic* use is noted in italic, so too might is *plastic* use be (Poersken, 2004). This suggestion is laudable for the general public to be made aware of plastic words, but not necessarily directly helpful to the wayward scientists who, stuck between a rock and a hard place, does not want to use such vague terms and yet cannot use any other term to describe without some sacrifice of clarity or scientific integrity. Here I offer my own practical suggestion for those scientists who use this kind of language but want to avoid the effects of inaccessibility, confusion, or impenetrability.

How to "call out" the word.

1. Name them.
2. Define them in the context of how they are being used in your specific paper.
3. Bring attention to the fact that their definitions are variable and change from context to context.

For example, if I must use the word 'communication' in a document I would write this near the beginning of my document:

> *Definition of Key Terms*
>
> There are several words I use in this paper which I wish to call attention to, because they are used in many different disciplines and carry many different

connotations, meanings or associations. To avoid confusion, I wish to call attention to how I am using this word in this context.

Communication: Used in the context of this document, communication means the act of speaking, writing, or otherwise using language to convey thoughts and ideas. I am speaking only of communication between human beings.

Many scientific papers will define a specific term they use if they want to convey a specific meaning. However, these papers rarely call attention to those words as being used variably in other contexts. This is a key step, I think, towards lessening the power of these variable words. The more they are called out, the more people will be aware of their power, and the words will be made powerless. As they are called out more and more in this manner, when these words are used in confusing and inaccessible ways, they no longer will be met with silence. Rather, they will be met with the question, "What do you mean when you use this word?".

Here is an example from a paper that invokes plastic words as it calls out the word "sustainability" and proposes ideas as to why the word sustainability carries some referential characteristics of plastic words:

> Does the sheer flexibility of 'sustainability' imply that the term is unfit for use? Is it one of those 'plastic words' (Poerksen 1995) that need conceptual repair work? In this book we have taken another route by stressing that the conceptual weakness of the term has important consequences: since the co-existence of different articulations allows various interests to be combined, the term allows the alignment of different stakeholders with their own perspectives, so facilitating joint efforts. A single interpretation of 'sustainable' would make these joint

> efforts less likely. The co-existence of different articulations also gives rise to dilemmas and paradoxes. When, for instance, EU guidelines translate the abstract notion of 'sustainable use of cars' into a requirement for cars to contain a certain percentage of recyclable material, it forces car design engineers to be more creative and responsible but, at the same time, rules out designs using lighter non-recyclable materials that translate 'sustainable use of cars' into 'less fuel use'. In this book, we have avoided using the terms 'sustainability' or 'sustainable development' in a narrow prescriptive sense because we wanted to reveal the tensions. For example, calling wind turbines 'sustainable' implies that adversaries of wind turbines—such as those arguing in favour of landscape amenity or bird protection—are opposed to sustainable development or are merely addressing minor side-effects of a 'good' technology. Moreover, there are futures without wind turbines, without nuclear power stations, without biofuels, and they might all be sustainable. Calling a technology 'sustainable' can often be a way of derailing any criticism of it. The concept of SD is often criticized as being vague and ill-defined. However, in our view, it is not so much vagueness as levels of analysis that are being confused: at some levels concepts can be defined and calculated (Mulder et al., 2017: p 236-237).

So I will end this piece by calling out a term. While it is not a plastic word, I still believe it warrants being re-examined, made clear and critiqued. That term is *invasive species.*

Invasive species is a word I use in this paper which I wish to call attention to, because it is used in many different ways and carries many different connotations, meanings, and associations. It can be used to mean anything ranging from a fatal germ to an ugly plant.

The word *invasive* is militaristic, and the term came about in post war era, and carries militaristic connotations which historically have linked to xenophobia and confusion. What invasive species refers to is also a source of confusion. Harm can be subjective and differ from person to person. Therefore, the invasive species I refer to in this paper are *these particular species*. I call them *invasive* because they cause *this particular kind of harm.*

Concluding Remarks

In general, my data collection has this narrative: 1: Determine if invasive species management has plastic words by coding documents. 2: Discover if plastic words are used plastically by monitoring their effects in survey responses. 3: Obtain understanding and perspective of translating from scientific ways of writing to a way of communicating these findings with the public in accessible way, by conducting interview. 4: Experiment with translation, eliminating metaphor, plastic words, and the plastic words infection of the rest of the words.

The invasive species documents contained enough plastic words to warrant consideration and rethink ways of expressing and communicating findings. The survey responses suggest to me that the phrasing, word choice, sentence structure etc. impede a general comprehension. This document consisted of 542 words, which seems relatively short. Regardless, the document was confusing and difficult to understand by enough people to warrant consideration in how to phrase and word these sorts of documents for the public. This document has the plastic word effect of silence. While plastic words were not necessarily the source of confusion, the way words were used—i.e. interchangeably or with varying definitions – reflects a fundamental attribute of plastic words. The fault is not just within this list of 46 problematic variable words—plastic is a phenomenon that does not just occur with these plastic words, but is a more general way of inaccessibly communicating to the public. Communicating to the public in a plastic manner will invariably include using a significant number of plastic words. However, as I learned from my own original translation, simply eliminating plastic words from the document does not seem to necessarily clarify meaning. It is imperative to prioritize an audience,

and it is imperative to understand what an audience will and will not understand. However, this does not mean one should rely on similarly problematic rhetoric that can be misleading in promoting a singular narrative. I think it is important to follow the rule: "when in doubt, call it out". But one could end up with a lengthy list of variable words at the beginning of a paper which could serve as an inaccessible and abstracting preface, undermining the rest of the work. Further, calling out words only gets to one part of the issue I have been describing with how science is communicated. There are still fundamental problems with its elitism and inability to incorporate other perspectives. These results demonstrate the tendency of plastic words to warp the meaning, sentiment, and effect of any passage, paragraph or policy they touch. Plastic words, which lend any document dubious conceptual authority, render the rest of that document vague and hollow by association. It is difficult to affect meaning when one's message is structured in relation to the meaningless plastic words. Thus, by virtue of words such as 'development', 'program', and 'management', a whole proposal is emptied of linguistic precision and, ultimately, meaning. Therefore, the count of plastic words per document is less important than their mere presence. Plastic words turn the language they neighbor into purgatory.

Good writing, and good communicating are skills that must be learned and honed. In science, what gets in the way most clearly of good writing is the lure of objectivity that eliminates the human being behind the words. Of a document riddled with plastic words, Uwe Poersken notes: "In such statements one can hear no voice" (Poersken, 2004, p. 18). Conveying notions about nature is difficult, and it must be conventionally formal, and academic. However, this does not mean we need to sacrifice form, style or art and that

human being, to convey it. Storytelling is and always will be the oldest form of learning a lesson. Simple eradication of plastic words does not cleanse the rest of the document of their impenetrable and vague plasticity. Stylistic elements without manipulation or simplification, humility, humanity and an appeal for other stories are, I think, fundamental characteristics of writing and communication that will invite comprehension and important collaboration.

A Few Suggestions for Future Work

Future work could include more cross analysis between disciplines of how prominent plastic words are, and comparison comprehensibility and reaction to translations which eliminate problematic words. Future work could also include studying the effects of comprehension and reaction when works include list of key problem terms at outset compared to works that do not include key problem words at outset. Future work could also include offering original key document to surveyors, and offering translated document to other surveyors to identify difference in read-difficulty. Future work should in general be about how to write more clearly, effectively, accessibly and democratically when conveying influential scientific information to the public.

Chapter 6: Conclusion

My work has been primarily a critique of the language used in science. I have explored the nuances of a militaristic metaphoric paradigm as well as the issues with reliance on the variable language of plastic words. We know how militaristic metaphor works to persuade of a simplifying and misleading narrative around invasive species. When metaphor is combined intrinsically with plastic words, the effect is that the narrative is protected both by inaccessible language that tells a false metaphorical story which resonates intrinsically with our greatest fears. Intentionally or not, this combination makes conversation with this sub-discipline impossible. This asociality of invasive species sub-discipline of science extends into other realms of science. I would like to end by exploring and expanding upon this critique of language in science, and critique the literal dominant language by which science is communicated—English.

As we have explored, historically Latin was the preferred objective yet undemocratic language of science. Today English is the dominant tongue by which the story of science is told. An Atlantic article asks the question I hope to answer in their article entitled: "The Hidden Bias of Science's Universal Language: The vast majority of scientific papers today are published in English. What gets lost when other languages get left out?" (2015). The author, Adam Huttner-Koros, cites a *Research Trends* study from 2012 that found that 80 percent of over 21,000 articles coming from 239 different countries in SCOPUS[4] were written in English (Huttner-Koros, 2015). English is so common in other countries that academic papers written in English will outnumber academic papers written in other country's own languages "several times over" (Huttner-

[4] SCOPUS is one of the biggest databases for peer-reviewed journals in the world.

Koros, 2015)**.** In the Netherlands, it's a ratio of 40 English-written academic texts to 1 academic text written in the native tongue Dutch (Huttner-Koros, 2015). This is clear too when English scientific jargon is created too quickly to be translated, and "words 'quark' and 'chromosome,' … are simply transliterated from English" (Huttner-Koros, 2015). Paraphrasing linguist Joe Lo Bianco, the Atlantic article explains the phenomenon of domain collapse— "as a language stops adapting to changes in a given field, it can eventually cease to be an effective means of communication in certain contexts altogether" (Huttner-Koros, 2015). The Atlantic article quotes a researcher of science communication Sean Perera,

> "The English language plays a dominant role, one could even call it a hegemony … As a consequence, minimal room or no room at all is allowed to communicators of other languages to participate in science in their own voice— they are compelled to translate their ideas into English. In practice, this attitude selects for only a very specific way of looking at the world, one that can make it easy to discount other types of information as nothing more than folklore" (Huttner-Koros, 2015).

Or as Shiva suggests "primitive" or "unscientific" (Shiva, 2003, p.10). Quoting Perera, The Atlantic article argues that with English being the dominating way of explaining science, scientists from other cultures are made to relinquish their language in order to be heard. This shunting away of other languages comes at 'the great cost of losing their unique ways of communicating ideas" (Huttner-Koros, 2015). It is this piece that I am primarily concerned with, that the space for other languages, other ways of seeing the world is growing smaller and smaller. As we know from semiotics, language is not simply a word referring to a thing. Language is another way of seeing the world. There is a vast system of meaning, interpreting and perceiving that exist uniquely within each

culture and language. Each different language gives a wholly unique perspective. Today, not only is there less room for other languages, but also they are fading away, dying off. They are going extinct. As these other languages disappear, as Perera says “other ways of understanding the world can simply fade away” (Huttner-Koros, 2015).

It is not only in science that English is dominant. Wolfgang Sachs and Poersken both comment on a similar extinction. Beginning with the statistic that 5103 languages exist, Poersken explores how they are stacked up, hierarchically, pyramidal. Citing Nigeria and India as reference points, Poersken explains while a diverse array of many different languages exist in these regions (over 400 in Nigeria and 1652 in Coulmas India) English is the predominant language of official discourse in these countries. Poersken writes:

> Asia and Africa each speak 30 percent of the world’s living languages, the Pacific region 20 percent, and the American content 16 percent. Europe, by contrast, has barely one percent—sixty-seven languages. In the birthplace of the nation state, therefore, the number of minorities is the smallest; the number of languages is barely double the number of states. Can we conclude from this that the nation state extinguishes languages? In every case history shows us that the modern state pushes them to the margins (Poersken, 2004, p. 2)

It comes to head as “a reduction of diversity” (Poersken, 2004, p. 3) and a rise of a monoculture of English. “Wherever we look” Poersken notes, “fewer kinds in ever fewer variants of corn and rice and wheat; Chinese, Russian, and English; and sheep, cattle, and pigs look back at us” (Poersken, 2004, p. 3). We can see here how a monoculture formed from these dominating species and races decreases diversity and biodiversity. Yet recall how bathua, locally beneficial plant, is labelled weed to maintain the growth of marketable wheat. Poersken explains that, “Five languages cover almost

half the earth, a hundred languages almost all of it. The universalist orientation to the nation state destroys the diversity of living languages. But even these triumphant languages are not the peak of the linguistic pyramid" (Poersken, 2004, p. 2).

It is not just English sitting atop this linguistic pyramid, Poersken warns us. "The peak is comprised of that small and spreading international vocabulary of a hundred, or fifty, or fifteen words…" (Poersken, 2004, p. 2). He is speaking, of course, of the tyrannical plastic words which sit atop, dominate and infect languages, across borders and cultures.

A diverse number of languages, over 5000, exist across the globe, and most are tucked away in little distant corners the earth: "They hide out in isolated mountain valleys, far-off islands and inaccessible deserts" (Sachs, 1999, p. 93). However, it is believed that within one hundred or two hundred years, global language count will decrease to just a few hundred (Sachs, 1999). Sachs compares this extinction of languages to the great loss of biodiversity we are facing as we enter what many consider the seventh mass extinction. He writes:

> Languages are dying out every bit as quickly as species. While, in the latter case, plants and animals disappear from the history of nature never to be seen again, with the demise of languages, entire cultures are vanishing form the history of civilization, never to be lived again. For each tongue contains its own way of perceiving man and nature, experiencing joy and sorrow, and finding meaning in the flow of events. To pray or to love, to dream or to reason, evoke different things when done in Farsi, German or Zapotec. Just as certain plants and animals are responsible for the maintenance of large ecosystems, so languages often carry subtle cultures through time. Once species disappear, ecosystems break down once languages die out, cultures falter (Sachs, 1999, p. 93).

We can see here a parallel between how scientists perceive of invasive species, and how the English language dominates, colonizes and wipes out. As we face the death of other species, we are also facing now is the death of alternate perspectives. Biodiversity loss and cultural diversity loss march together across the planet. But one is receiving far more attention than the other just as the one causes the other. As Sachs explains, "Along with languages, entire conceptions of what it means to be human have evaporated during the development decades since 1950" (Sachs, 1999, p. 94). Language is the way in which people perceive their world. Words paint the world with color, culture, history and context. A rose without Romeo would be far less romantic. Grimly, Sachs notes that "Whichever way one looks at it, the homogenization of the world is in full swing. A global monoculture spreads like an oil slick over the entire planet (Sachs, 1999, p. 94). This monocultural oil-slick eliminates other ways of thinking and being in the world. Wiping out more descriptive words, different cultures, making them obsolete under the banner of "development" allows but a single narrative of development to flourish. Shiva writes, "The historical experience of non-western culture suggests that it is the western systems of knowledge which are blind to alternatives" (Shiva 2003, p. 11). The road to knowledge is littered with wide-eyed corpses—other ways of seeing. A military metaphor is apt here—it suggests that we will win and they will lose. *We* are the dominant perspective of development and *they* are any other perspective. As English is the dominant language of Science, plastic words the dominant words of the powerful, and militarism a dominant metaphor of persuasion we can see clearly how these factors all combine in a monoculture colonialist perspective. We bemoan the loss of biodiversity,

but hypocritically maintain a largely single, monocultural perspective. Vandana Shiva notes:

> Dominant scientific knowledge thus breeds a monoculture of the mind by making space for local alternatives disappear, very much like monocultures of introduced plant varieties leading to the displacement and destruction of local diversity. Dominant knowledge also destroys the very conditions for alternatives to exist, very much like the introduction of monocultures destroying the very conditions for diverse species to exist" (Shiva, 2003, p. 12)

It is an issue, as Vandana Shiva explores in her text *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology*, of local versus global knowledge. She argues that under the regime of globally dominant way of knowing through science, "local knowledge is made to disappear by simply not seeing it, by negating its very existence" (Shiva, 2003, p. 9). By local knowledge, she means traditionalist, often indigenous ways of knowing, which are unfortunately synonymous with "'primitive' and 'unscientific'" (Shiva, 2003, p. 10). Shiva writes "Correspondingly, the western system is assumed to be uniquely 'scientific' and universal. The prefix 'scientific' for the modern systems, and 'unscientific' for the traditional knowledge systems has, however, less to do with knowledge and more to do with power" (Shiva 2003 p. 10).

In this way of perceiving the world, "western systems of knowledge have generally been viewed as universal" (Shiva 2003 p. 9-10). Yet in this dichotomous clash of local knowledge versus global knowledge, we forget that our current western global science knowledge is from a "local system, with its social basis in a particular culture, class and gender. It is not universal in an epistemological sense. It is merely the globalized version of a very local and parochial tradition" (Shiva, 2003 p. 9). It is this

misappropriation of knowledge whereby **"**Power is also built into the perspective which views the dominant system not as a globalized local tradition, but as a universal tradition, inherently superior to local systems" (Shiva, 1999, p. 9-10). Our dominant system was once local, and now has colonizes the world, pushing away alternate perspectives in its path.

For the record, I do not want to be miscritiqued as Bruno Latour has been 40 years ago—as undermining science's credibility. I would not be able to write this thesis if science weren't credible. Yet it burns my tongue too to say that "global warming is a fact whether you like it or not" (Latour, 2003), not because I don't believe in global warming, but because I don't think we can profess something as fact so emphatically without room for conversation and argument. Today, Shiva writes, "Modern western science is not to be evaluated, it is merely to be accepted" (Shiva, 2003 p. 12). I understand the dire state that has thrown us who want minimize climate change into flurry against climate change deniers, but it is this dichotomous way of thinking and rejecting *the others* that will be our whole undoing. Moreover, it is largely if not completely because of science and technology that our planet is in danger. Where would our planet be if it were not for yesterday's cars of tomorrow which today collectively burp millions of tons of polluting carbon dioxide into the air each year, heating up our planet and causing global environmental devastation? What of yesterday's tomorrow's new nuclear power, the waste of which today cannot be destroyed, which toxifies anything it touches so the best way we can handle it is to submerge it carefully in water and bury deep within the earth and pray no one stumbles upon it within its 24,000-year half-life (Madsen, 2010). Our understanding of science is incomplete, and we are blinded

by our own comfort. Science undoubtedly has illuminating merits—it is not the credibility of science I am questioning—only the ways by which science holds its perspective as dominant above all else and the visible faults that we can see within this undemocratic way of performing, here and in the third world. The scientific worldview is not the only worldview, despite how it is perceived. It is this colonization of belief that needs to be rethought and untaught.

I believe in a reflexive, conversational, social and democratic science. I believe that by humbling science we can elevate it. Allowing room and space for public engagement, by removing issues of inaccessibility or misleading narratives as best we can and speaking clearly, honestly, and humbly about what we believe based on what we see, will be, I think the kindest and most important ways to take on and work out that which is difficult and harmful. And we must do this communally, democratically, together, as one.

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Appendices

Appendix 1: Plastic Words Characteristics

A. Origin and Usage

1. The speaker lacks the power of definition; the words do not acquire meaning or nuance from their contexts.
2. As "context-autonomous" words that do not depend on their connections, they superficially resemble the terms of science, but lack the precisely defined meanings of such terms, and their freedom from associations. The use of the same word inside and outside science leads to the assumption of kinship, and to the words becoming independent norms. In the vernacular, these nephews of science become stereotypes.
3. As a rule they originate in the vernacular, are adopted and reshaped by some brand of science, and then, like returning émigrés, rejoin the vernacular.
4. They have the character of metaphors inasmuch as they link the heterogeneous spheres of science and everyday life. They are distinct from metaphors in that they no longer evoke any image; they do not, like other comparisons, indicate their origin.
5. This makes their capacity to alter and illuminate their objects even more powerful. The less obvious their metaphorical character, the less it is noticed, and the more effectively it works. These words become commonsense, background concepts in our thinking.

B. Scope

6. The words surface in countless contexts. Their application is limited hardly at all by space or time.
7. They squeeze out and replace a wealth of synonyms. Synonyms after all are not words whose meaning is the same but whose meaning is similar, words with as many delicate differences and shadings as there are contexts. Before plastic words one knew which synonym belonged in which factual or social context. Now there is a "jack of all trades," a word that serves the whole world.
8. They squeeze out and replace the *verbum proprium*, which precisely "fits" in a given context, with a nonspecific word.
9. They fill silences and replace indirect ways of speaking, exposing delicacy and tact to the action of stereotyped generalities.

C. Content

10. When we seek to grasp the meaning of the words, through their content rather than their sphere of influence, it comes down to a single characteristic. They manifest the logical law of the inverse proportionality of extension and intention: the broader the application, the smaller the content; the poorer the content, the larger the application. They are words that reduce a gigantic area to a common denominator. They put forward a universal claim, with a reduced and impoverished content.
11. In other words, the object spoken about, the referent, is not easy to grasp; the words are poor in substance, if not altogether without substance.

12. They seem to resemble the concepts of postclassical physics: purely imaginary, meaningless, self-referential, and functioning only as stackable poker chips. Is language being undermined in parallel with the use of these poker chips in the thought structures of mathematics and physics?

D. History as Nature

13. The words lack a historical dimension; they are embedded in no particular time or place. In that sense they are shallow; they are new and they don't taste of anything.
14. They reinterpret history as nature and transform it into a laboratory.
15. They dispense with questions of good and evil and cause them to disappear.

E. Power of Connotation and Function

16. Connotation dominates, spreading out in expanding waves. In place of the power of denotation, they provide an experience of counterfeit enlightenment.
17. Their connotation is positive; they formulate a property or deliver the illusion of an insight.
18. In their usage the *function* of the discourse dominates, not its content. These words are more like an instrument of subjugation than like a tool of freedom.

F. General Function

19. By means of their limitless generality they give the impression of filling a gap and of satisfying a need that had not previously existed. In other words, they awaken a need. They reduce all domains to a common denominator and sound an imperative and futuristic note. The words seem to demand that these domains adjust themselves to the words and not vice versa. They draw attention to deficits.
20. Their asocial and ahistorical naturalness reinforces this demand.
21. Their powerful aura of associations demands action.
22. Their many-sided generality brings about consensus.

G. Social and Economic Usefulness

23. Their use distinguishes the speaker from the unremarkable world of the everyday and raises his social prestige; they serve him as rungs on the social ladder.
24. They carry the authority of science into the vernacular: they enforce silence. (In the GDR Marxist-Leninist science was already monumentalized by being the explicit foundation of the state structure. In the Federal Republic the scientific vocabulary pushed itself into a comparable position as an instrument for awakening economic needs.)
25. These words form a bridge to the world of experts. Their content is actually no more than a white spot, but they transmit the "aura" of another world, in which one can obtain information about them. They anchor, in the vernacular, the need for experts. They are pregnant with money. They command resources, and, in the hands of experts, become resources.
26. They can be freely combined, and they are eager to increase themselves through derivation and the creation of compounds. This modular capacity makes them an ideal

instrument in the hands of experts interested in the speedy manufacture of models of reality.

H. Time and Place of Dissemination

27. Their scientifically authorized objectivity and universality make the older words of the vernacular appear ideological. A word like “communication” makes alternatives – conversation, discussion, gossip suddenly appear out of date.
28. The words appear as a new type. In recent history such newcomers have evidently been introduced in each epoch. The type in vogue in the 1930s is not the type in vogue in the 1990s.
29. This vocabulary, even if it appears at slightly different times in different places, is international.

I. Connection to Making Oneself Understood without Words

30. The words cannot be made clearer by tone of voice, pantomime, or gesture, and cannot be replaced by these.

Appendix 2: Full Description of King Saloman's House

"God bless thee, my son; I will give thee the greatest jewel I have. For I will impart unto thee, for the love of God and men, a relation of the true state of Salomon's House. Son, to make you know the true state of Salomon's House, I will keep this order. First, I will set forth unto you the end of our foundation. Secondly, the preparations and instruments we have for our works. Thirdly, the several employments and functions whereto our fellows are assigned. And fourthly, the ordinances and rites which we observe. "The end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible. "The Preparations and Instruments are these. We have large and deep caves of several depths: the deepest are sunk six hundred fathom: and some of them are digged and made under great hills and mountains: so that if you reckon together the depth of the hill and the depth of the cave, they are (some of them) above three miles deep. For we find, that the depth of a hill, and the depth of a cave from the flat, is the same thing; both remote alike, from the sun and heaven's beams, and from the open air. These caves we call the Lower Region; and we use them for all coagulations, indurations, refrigerations, and conservations of bodies. We use them likewise for the imitation of natural mines; and the producing also of new artificial metals, by compositions and materials which we use, and lay there for many years. We use them also sometimes, (which may seem strange,) for curing of some diseases, and for prolongation of life in some hermits that choose to live there, well accommodated of all things necessary, and indeed live very long; by whom also we learn many things. "We have burials in several earths, where we put diverse cements, as the Chineses do their porcellain. But we have them in greater variety, and some of them more fine. We have also great variety of composts and soils, for the making of the earth fruitful. "We have high towers; the highest about half a mile in height; and some of them likewise set upon high mountains; so that the vantage of the hill with the tower is in the highest of them three miles at least. And these places we call the Upper Region; accounting the air between the high places and the low, as a Middle Region. We use these towers, according to their several heights, and situations, for insolation, refrigeration, conservation; and for the view of divers meteors; as winds, rain, snow, hail; and some of the fiery meteors also. And upon them, in some places, are dwellings of hermits, whom we visit sometimes, and instruct what to observe. "We have great lakes, both salt, and fresh; whereof we have use for the fish and fowl. We use them also for burials of some natural bodies: for we find a difference in things buried in earth or in air below the earth, and things buried in water. We have also pools, of which some do strain fresh water out of salt; and others by art do turn fresh water into salt. We have also some rocks in the midst of the sea, and some bays upon the shore for some works, wherein is required the air and vapor of the sea. We have likewise violent streams and cataracts, which serve us for many motions: and likewise engines for multiplying and enforcing of winds, to set also on going diverse motions. "We have also a number of artificial wells and fountains, made in imitation of the natural sources and baths; as tincted upon vitriol, sulphur, steel, brass, lead, nitre, and other minerals. And again we have little wells for infusions of many things, where the waters take the virtue quicker and better, than in vessels or basins. And amongst them we have a water which we call Water of Paradise, being, by that we do to it made very sovereign for health, and prolongation of life. "We have also

great and spacious houses where we imitate and demonstrate meteors; as snow, hail, rain, some artificial rains of bodies and not of water, thunders, lightnings; also generations of bodies in air; as frogs, flies, and divers others. “We have also certain chambers, which we call Chambers of Health, where we qualify the air as we think good and proper for the cure of divers diseases, and preservation of health. “We have also fair and large baths, of several mixtures, for the cure of diseases, and the restoring of man’s body from arefaction: and others for the confirming of it in strength of sinewes, vital parts, and the very juice and substance of the body. “We have also large and various orchards and gardens; wherein we do not so much respect beauty, as variety of ground and soil, proper for divers trees and herbs: and some very spacious, where trees and berries are set whereof we make divers kinds of drinks, besides the vineyards. In these we practise likewise all conclusions of grafting, and inoculating as well of wild-trees as fruit-trees, which produceth many effects. And we make (by art) in the same orchards and gardens, trees and flowers to come earlier or later than their seasons; and to come up and bear more speedily than by their natural course they do. We make them also by art greater much than their nature; and their fruit greater and sweeter and of differing taste, smell, colour, and figure, from their nature. And many of them we so order, as they become of medicinal use.

“We have also means to make divers plants rise by mixtures of earths without seeds; and likewise to make divers new plants, differing from the vulgar; and to make one tree or plant turn into another. “We have also parks and enclosures of all sorts of beasts and birds which we use not only for view or rareness, but likewise for dissections and trials; that thereby we may take light what may be wrought upon the body of man. Wherein we find many strange effects; as continuing life in them, though divers parts, which you account vital, be perished and taken forth; resuscitating of some that seem dead in appearance; and the like. We try also all poisons and other medicines upon them, as well of chirurgery, as physic. By art likewise, we make them greater or taller than their kind is; and contrariwise dwarf them, and stay their growth: we make them more fruitful and bearing than their kind is; and contrariwise barren and not generative. Also we make them differ in colour, shape, activity, many ways. We find means to make commixtures and copulations of different kinds; which have produced many new kinds, and them not barren, as the general opinion is. We make a number of kinds of serpents, worms, flies, fishes, of putrefaction; whereof some are advanced (in effect) to be perfect creatures, like bests or birds; and have sexes, and do propagate. Neither do we this by chance, but we know beforehand, of what matter and commixture what kind of those creatures will arise. “We have also particular pools, where we make trials upon fishes, as we have said before of beasts and birds. “We have also places for breed and generation of those kinds of worms and flies which are of special use; such as are with you your silk-worms and bees. “I will not hold you long with recounting of our brewhouses, bake-houses, and kitchens, where are made divers drinks, breads, and meats, rare and of special effects. Wines we have of grapes; and drinks of other juice of fruits, of grains, and of roots; and of mixtures with honey, sugar, manna, and fruits dried, and decocted; Also of the tears or woundings of trees; and of the pulp of canes. And these drinks are of several ages, some to the age or last of forty years. We have drinks also brewed with several herbs, and roots, and spices; yea with several fleshes, and white-meats; whereof some of the drinks are such, as they

are in effect meat and drink both: so that divers, especially in age, do desire to live with them, with little or no meat or bread. And above all, we strive to have drink of extreme thin parts, to insinuate into the body, and yet without all biting, sharpness, or fretting; insomuch as some of them put upon the back of your hand will, with a little stay, pass through to the palm, and yet taste mild to the mouth. We have also waters which we ripen in that fashion, as they become nourishing; so that they are indeed excellent drink; and.many will use no other. Breads we have of several grains, roots, and kernels; yea and some of flesh and fish dried; with divers kinds of leavenings and seasonings: so that some do extremely move appetites; some do nourish so, as divers do live of them, without any other meat; who live very long. So for meats, we have some of them so beaten and made tender and mortified,' yet without all corrupting, as a weak heat of the stomach will turn them into good chylus; as well as a strong heat would meat otherwise prepared. We have some meats also and breads and drinks, which taken by men enable them to fast long after; and some other, that used make the very flesh of men's bodies sensibly' more hard and tough and their strength far greater than otherwise it would be.

"We have dispensatories, or shops of medicines. Wherein you may easily think, if we have such variety of plants and living creatures more than you have in Europe, (for we know what you have,) the simples, drugs, and ingredients of medicines, must likewise be in so much the greater variety. We have them likewise of divers ages, and long fermentations. And for their preparations, we have not only all manner of exquisite distillations and separations, and especially by gentle heats and percolations through divers strainers, yea and substances; but also exact forms of composition, whereby they incorporate almost, as they were natural simples. "We have also divers mechanical arts, which you have not; and stuffs made by them; as papers, linen, silks, tissues; dainty works of feathers of wonderful lustre; excellent dies, and, many others; and shops likewise, as well for such as are not brought into vulgar use amongst us as for those that are. For you must know that of the things before recited, many of them are grown into use throughout the kingdom; but yet, if they did flow from our invention, we have of them also for patterns and principals. "We have also furnaces of great diversities, and that keep great diversity of heats; fierce and quick; strong and constant; soft and mild; blown, quiet; dry, moist; and the like. But above all, we have heats, in imitation of the Sun's and heavenly bodies' heats, that pass divers inequalities, and (as it were) orbs, progresses, and returns, whereby we produce admirable effects. Besides, we have heats of dungs; and of bellies and maws of living creatures, and of their bloods and bodies; and of hays and herbs laid up moist; of lime unquenched; and such like. Instruments also which generate heat only by motion. And farther, places for strong insulations; and again, places under the earth, which by nature, or art, yield heat. These divers heats we use, as the nature of the operation, which we intend, requireth. "We have also perspective-houses, where we make demonstrations of all lights and radiations; and of all colours: and out of things uncoloured and transparent, we can represent unto you all several colours; not in rain-bows, (as it is in gems, and prisms,) but of themselves single. We represent also all multiplications of light, which we carry to great distance, and make so sharp as to discern small points and lines. Also all colourations of light; all delusions and deceits of the sight, in figures, magnitudes, motions, colours all demonstrations of shadows. We find also divers means, yet unknown to you, of producing of light originally from divers bodies. We procure means of seeing objects afar off; as in the heaven and remote places; and

represent things near as afar off; and things afar off as near; making feigned distances. We have also helps for the sight, far above spectacles and glasses in use. We have also glasses and means to see small and minute bodies perfectly and distinctly; as the shapes and colours of small flies and worms, grains and flaws in gems, which cannot otherwise be seen, observations in urine and blood not otherwise to be seen. We make artificial rain-bows, halo's, and circles about light. We represent also all manner of reflexions, refractions, and multiplications of visual beams of objects. "We have also precious stones of all kinds, many of them of great beauty, and to you unknown; crystals likewise; and glasses of divers kinds; and amongst them some of metals vitrificated, and other materials besides those of which you make glass. Also a number of fossils, and imperfect minerals, which you have not. Likewise loadstones of prodigious virtue; and other rare stones, both natural and artificial.

"We have also sound-houses, where we practise and demonstrate all sounds, and their generation. We have harmonies which you have not, of quarter-sounds, and lesser slides of sounds. Divers instruments of music likewise to you unknown, some sweeter than any you have, together with bells and rings that are dainty and sweet. We represent small sounds as great and deep; likewise great sounds extenuate and sharp; we make divers tremblings and warblings of sounds, which in their original are entire. We represent and imitate all articulate sounds and letters, and the voices and notes of beasts and birds. We have certain helps which set to the ear do further the hearing greatly. We have also divers strange and artificial echoes, reflecting the voice many times, and as it were tossing it: and some that give back the voice louder than it came, some shriller, and some deeper; yea, some rendering the voice differing in the letters or articulate sound from that they receive. We have also means to convey sounds in trunks and pipes, in strange lines and distances. "We have also perfume-houses; wherewith we join also practices of taste. We multiply smells, which may seem strange. We imitate smells, making all smells to breathe outs of other mixtures than those that give them. We make divers imitations of taste likewise, so that they will deceive any man's taste. And in this house we contain also a confiture-house; where we make all sweet-meats, dry and moist; and divers pleasant wines, milks, broths, and sallets; in far greater variety than you have. "We have also engine-houses, where are prepared engines and instruments for all sorts of motions. There we imitate and practise to make swifter motions than any you have, either out of your muskets or any engine that you have: and to make them and multiply them more easily, and with small force, by wheels and other means: and to make them stronger and more violent than yours are; exceeding your greatest cannons and basilisks. We represent also ordnance and instruments of war, and engines of all kinds: and likewise new mixtures and compositions of gun-powder, wild-fires burning in water, and unquenchable. Also fireworks of all variety both for pleasure and use. We imitate also flights of birds; we have some degrees of flying in the air. We have ships and boats for going under water, and brooking of seas; also swimming-girdles and supporters. We have divers curious clocks, and other like motions of return: and some perpetual motions. We imitate also motions of living creatures, by images, of men, beasts, birds, fishes, and serpents. We have also a great number of other various motions, strange for equality, fineness, and subtilty. "We have also a mathematical house, where are represented all instruments, as well of geometry as astronomy, exquisitely made. "We have also houses

of deceits of the senses; where we represent all manner of feats of juggling, false apparitions, impostures, and illusions; and their fallacies. And surely you will easily believe that we that have so many things truly natural which induce admiration, could in a world of particulars deceive the senses, if we would disguise those things and labour to make them seem more miraculous. But we do hate all impostures, and lies; insomuch as we have severely forbidden it to all our fellows, under pain of ignominy and fines, that they do not show any natural work or thing, adorned or swelling; but only pure as it is, and without all affectation of strangeness.

"These are (my son) the riches of Salomon's House. "For the several employments and offices of our fellows; we have twelve that sail into foreign countries, under the names of other nations, (for our own we conceal); who bring us the books, and abstracts, and patterns of experiments of all other parts. These we call Merchants of Light. "We have three that collect the experiments which are in all books. These we call Depredators. "We have three that collect the experiments of all mechanical arts; and also of liberal sciences; and also of practices which are not brought into arts. These we call Mystery-men. "We have three that try new experiments, such as themselves think good. These we call Pioneers or Miners. "We have three that draw the experiments of the former four into titles and tables, to give the better light for the drawing of observations and axioms out of them. These we call Compilers. "We have three that bend themselves, looking into the experiments of their fellows, and cast about how to draw out of them things of use and practise for man's life, and knowledge, as well for works as for plain demonstration of causes, means of natural divinations, and the easy and clear discovery of the virtues and parts of bodies. These we call Dowry-men or Benefactors. "Then after divers meetings and consults of our whole number, to consider of the former labours and collections, we have three that take care, out of them, to direct new experiments, of a higher light, more penetrating into nature than the former. These we call Lamps. "We have three others that do execute the experiments so directed, and report them. These we call Inoculators.

"Lastly, we have three that raise the former discoveries by experiments into greater observations, axioms, and aphorisms. These we call Interpreters of Nature. "We have also, as you must think, novices and apprentices, that the succession of the former employed men do not fail; besides, a great number of servants and attendants, men and women. And this we do also: we have consultations, which of the inventions and experiences which we have discovered shall be published, and which not: and take all an oath of secrecy, for the concealing of those which we think fit to keep secret: though some of those we do reveal sometimes to the state and some not. "For our ordinances and rites: we have two very long and fair galleries: in one of these we place patterns and samples of all manner of the more rare and excellent inventions in the other we place the statues of all principal inventors. There we have the statue of your Columbus, that discovered the West Indies: also the inventor of ships: your monk that was the inventor of ordnance and of gunpowder: the inventor of music: the inventor of letters: the inventor of printing: the inventor of observations of astronomy: the inventor of works in metal: the inventor of glass: the inventor of silk of the worm: the inventor of wine: the inventor of corn and bread: the inventor of sugars: and all these, by more certain tradition than you have. Then have we divers inventors of our own, of excellent works; which since you have not seen, it were too long to make descriptions of them; and besides, in the right understanding of those descriptions you might easily err. For upon every invention of

value, we erect a statue to the inventor, and give him a liberal and honourable reward. These statues are some of brass; some of marble and touch-stone; some of cedar and other special woods gilt and adorned; some of iron; some of silver; some of gold. “We have certain hymns and services, which we say daily, of Lord and thanks to God for his marvellous works: and forms of prayers, imploring his aid and blessing for the illumination of our labours, and the turning of them into good and holy uses. “Lastly, we have circuits or visits of divers principal cities of the kingdom; where, as it cometh to pass, we do publish such new profitable inventions as we think good. And we do also declare natural divinations of diseases, plagues, swarms-of hurtful creatures, scarcity, tempests, earthquakes, great inundations, comets, temperature of the year, and divers other things; and we give counsel thereupon, what the people shall do for the prevention and remedy of them.” And when he had said this, he stood up; and I, as I had been taught, kneeled down, and he laid his right hand upon my head, and said; “God bless thee, my son; and God bless this relation, which I have made. I give thee leave to publish it for the good of other nations; for we here are in God’s bosom, a land unknown.” And so he left me; having assigned a value of about two thousand ducats, for a bounty to me and my fellows. For they give great largesses where they come upon all occasions. [The rest was not perfected.]” (Bacon, 1627: 71-83).

Appendix 3: Executive Order 13112

In 1999, the president of the United States of America created, in collaboration, Executive Order 13112 to bring to light and address how non-native species upset certain perceived harmonies between human, plant, animal, and land. This document begins by defining terms that will be used, establishes the Invasive Species Council (ISC) and explains its duties, and requests the first National Invasive Species Management Plan (NISMP) which will be continually reviewed henceforth, and ends by explaining the purpose of this Executive Order and revoking previous incompatible Executive Orders.

https://www.gpo.gov/fdsys/pkg/FR-1999-02-08/html/99-3184.htm

Appendix 4: Five-Year Review of Executive Order 13112 on Invasive Species (2005)

This document is released every five years and is a review of the 1999 Executive Order (EO) 13112. This document assesses how effective the EO is and whether or not it should be revised. It summarizes EO 13112, explains and defines invasive species as they are perceived today, and examines how well the EO 13112 holds up. It examines the particular roles both the Invasive Species Advisory Committee (ISAC) and the NISC have, budgets, and various prevention measures. The conclusion of this report suggests that the NISC is working well to meet certain goals outlined in the EO 13112, and that in future the NISC will be able to address invasive species more effectively, despite challenges in interagency collaboration. It argues that Executive Order 13112 should be maintained.

https://www.invasivespeciesinfo.gov/docs/council/fiveyearreview.pdf

Appendix 5: Invasive Species Definition Clarification and Guidance White Paper (2006)

This document defines invasive species while acknowledging the difficulty of defining invasive species. It explains that "harm" is subjective and certain people may find a species harmful while other people may find that species beneficial. It suggests negative effects shall outweigh beneficial effects of a non-native species to deem it invasive. It discusses what is meant by native and non-native, how federal non-native species are more often potentially invasive than domestic non-native species, how a certain region may have negative effects from a non-native species while another, nearby region may have beneficial effects, and describes the various types of harm invasive species can inflict on: the environment, human health, natural resources, and recreational avenues.

https://www.invasivespeciesinfo.gov/docs/council/isacdef.pdf

Appendix 6: The Standard Operating Procedures for the Rapid Screening of Species' Risk of Establishment and Impact in the United States (2016)

This document describes a streamlined Standard Operating Procedure (SOP) to screen the potential risk of a non-native species. This procedure, if done properly, helps determine if a species can be labeled as "invasive" which would warrant regulatory action such as preventative measures or attempted eradication of that species. It describes who is best fit to perform these procedures, and on what sorts of species. It defines invasive species, and explains the difficulty in defining invasive species. It describes the purpose of the paper as to be guidelines for a procedure that can be replicated. It discusses difficulties in streamlining such a process. It describes the appropriate format by which a successfully enacted analysis should adhere to, including information on: nativity of species, ecological and biological information, impacts of introduction, global distribution, US distribution, climate matching, certainty of assessment, risk assessment, and references. It offers an example of a successfully conducted risk assessment procedure as a template.

https://www.fws.gov/injuriouswildlife/pdf_files/ERSS-SOP-Final-Version.pdf

Appendix 7: Executive Order 13751 Safeguarding the Nation from the Impacts of Invasive Species (2016)

This document from 2016 amends the Executive Order 13112, by expanding the NISC, clarifying NISC duties, reviewing and clarifying subjective invasive species definitions, and incorporates new technologies, changing climates, and other contemporary divergences from EO 13112. It defines terms used in the document, describes federal agency duties, assesses new emerging priorities and makes various amendments to EO 13112.

https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species

Appendix 8: Management Plan Report Card (2017)

This is a brief outline of the current plan for handling invasive species and their effects on humans, regions, economies.

https://www.doi.gov/sites/doi.gov/files/uploads/management_plan_report_card_2017_interim.pdf

Appendix 9: A Brief Overview of the Federal Trade Commission's Investigative and Law Enforcement Authority (2008)

This document explores the regulations, expectations, roles and investigative procedures of the law enforcement branch that deals with issues within the Federal Trade Commission (FTC). It begins by describing elements of the FTC act, then elaborates on how to handle a variety of unfair business practices that harm consumers.

https://www.ftc.gov/about-ftc/what-we-do/enforcement-authority

Appendix 10: Federal Trade Commission Draft Strategic Plan (2017)

This is a detailed outline of a three-part plan for 1) protecting consumers against unfair business practices, 2) promoting competition in the marketplace, and 3) generally strengthening the FTC's reach and scope through strategic dissemination of information.

https://www.ftc.gov/system/files/attachments/press-releases/ftc-releases-draft-strategic-plan-fiscal-years-2018-2022/draftstratplanfy18-22.pdf

Appendix 11: Survey Document Preamble

Please read the following document and respond to the questions provided. You may want to read the questions before reading the document:

Preamble: Executive Order 13112 – defines an invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." In the Executive Summary of the National Invasive Species Management Plan (NISMP) the term invasive species is further clarified and defined as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." To provide guidance for the development and implementation of the NISMP, the National Invasive Species Council (NISC) and the Invasive Species Advisory Committee (ISAC) adopted a set of principles outlined in Appendix 6 of the NISMP. Guiding Principle #1 provides additional context for defining the term invasive species and states "many alien species are non-invasive and support human livelihoods or a preferred quality of life." However, some alien species (non-native will be used in this white paper because it is more descriptive than alien), for example West Nile virus, are considered invasive and undesirable by virtually everyone. Other non-native species are not as easily characterized. For example, some nonnative species are considered harmful, and therefore, invasive by some sectors of our society while others consider them beneficial. This discontinuity is reflective of the different value systems operating in our free society, and contributes to the complexity of defining the term invasive species. NISC is engaged in evaluating and updating the 2001 NISMP and is developing comments for a revised action plan as required by the EO 13112. While there have been numerous attempts to clarify the term invasive species, there continues to be uncertainty concerning the use and perceived meaning of the term, and consequently over the prospective scope of actions proposed in the NISMP. Options related to private property use, pet ownership, agriculture, horticulture, and aquaculture enterprises may be affected depending upon the definition, use, and policy implications of the term. In particular, the desire to consider a non-native species as 'invasive' may trigger a risk/benefit assessment process to determine whether regulatory action is warranted. All these uncertainties have stood and could continue to stand in the way of progress in actions and policy development to prevent new invasions and manage existing invasive species. While it is not the purpose of this white paper to define a risk/benefit assessment process, development of such a process must be open and efficient to minimize the uncertainties. This white paper is intended to provide a non-regulatory policy interpretation of the term invasive species by identifying what is meant, and just as important, what is not meant by the term. ISAC recognizes that biological and ecological definitions will not precisely apply to regulatory definitions. We believe, however, that our clarification will apply to all taxa of invasive species in all habitats and furthermore, our explanation will be functional and acceptable to most stakeholders. ISAC simply wants to clarify what is meant and what is not meant by the term invasive species in the technical sense and to provide insight into those areas where societal judgments will be necessary to implement effective public policy. The utility of our clarification should be in education, conflict resolution, and efficiency in the planning, prevention, control/eradication, and management of invasive species.

Appendix 12: Survey Questions

1. On a scale of 1-10 where 1 stands for not very familiar and 10 stands for very familiar, how familiar are you with the way invasive species are talked about?
2. On a scale of 1-10 where 1 stands for very easy and 10 stands for very difficult, how easy or difficult was it for you to read and understand this document?
3. Which sections or sentences in this document are easiest to understand? Copy and paste portions here.
4. Which sections or sentences of this document are most difficult to understand? Copy and paste portions here.
5. List 3 to 5 words or phrases used in this document that are easier to understand or otherwise straight-forward. (You may chose words or phrases from your answer to question number 3).
6. List 3 to 5 words or phrases used in the document that are more difficult to understand or otherwise confusing. (You may chose words or phrases from your answer to question number 4).
7. Define what you think the words or phrases you chose for question 6 mean.
8. Briefly summarize what you think is being said in this paragraph.
9. Define invasive species in your own words.

Appendix 13: Semi-Formal Interview Questions

Can you explain to me in more detail how you would prepare and explain environmental impacts and statements?
While preparing environmental impacts and studies, were there certain inaccessible words, phrases, or ways of explanation that you would look for to replace?
What are a few examples, and what did you replaces those words or phrases with?
What did you find to be the most difficult part in preparing these documents?
What was the easiest?
Were there certain documents you felt that you were unable to make appropriately accessible? If so, why?
I would like to see an example of a document before you and your team worked on it and after you and your team worked on it. Unless you give me your permission, I will <u>not</u> share this document with anyone, or use it in my thesis. I would like to see these "before" and "after" documents so I can discern if I have any other questions I'd like to ask about this work.
I'd also like to know a little bit more about the scientific writing you did, specifically what did you write about and who did you write it for?