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SCIENTIFIC AND ETHICAL CONSIDERATIONS IN RARE SPECIES PROTECTION: THE CASE OF BEAVERS IN CONNECTICUT

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The protection of rare species abounds with scientific and ethical considerations. An ethical dilemma can emerge when the life of one species is valued higher than that of another, and so we discuss the basis of ranking, protection, and valuation of plants and animals. A duty to protect rare species exists in this age of great losses to plant and animal life, but the scientific and public communities are not always in agreement regarding what species deserve protection. Using a case study, we illustrate how the decision to kill beavers to protect a rare plant and rare animals found in a tidewater creek demanded an ecological ethic approach. We present the concept of a "conservation mediator" and how its use may help find a common ground between stakeholders and decision-makers in similar situations.

1. INTRODUCTION

The linked worldviews of ecology and evolutionary biology and ethics provide the foundation for environmental decision-making. Currently, the need to protect and conserve biodiversity has never been more important. Human-caused deforestation and defaunation have decreased the biodiversity of plants, animals, and ecosystems. Thus, an ecological ethic argument can be made towards a moral duty to preserve the environment and the life it supports (Rolston 1991a). To enact human duty towards nature, there inherently is the ethical dilemma of placing a conservation value on a species to determine the legal status of endangered or threatened and provide protection (Rolston 1985).

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The valuation of a species has ethical consequences, where one species is determined to rank higher in need of protection than another based on occurrence, range distribution, and potential or known threats to popula-tions or critical habitat. Basic dichotomies that challenge species valuation and ranking involve: 1) scientifically ascribed versus inherent values of species, and 2) scientific versus ethical decisions of protection and associ-ated justifications. Common to either dichotomy is that rarity becomes a relative rather than an absolute concept. However, a similar argument can be made regarding the objective versus subjective nature of determining rare species.

This dualism is apparent in the history of rare species protection and the resulting ethical dilemmas and controversies, where different stake-holders, such as government agencies, nonprofit entities, and environmen-talists often clash among opposing attitudes, perceptions, and knowledge. Classic examples include:

1. The planned and coordinated killing of sheep, feral pigs, rabbits, and hares affecting endemic insular biota in California and Mexico,
2. The killing of barred owls to protect the northern and California spotted owls, and
3. The killing of non-native brown trout with piscicide and the removal of non-native rainbow trout through gill netting to preserve native golden trout and prevent hybridization.

Each of these controversies illustrates scientific and ethical dilemmas and demonstrates the need to find a common ground between stakeholders and decision-makers regarding rare species protection.

In this paper, we juxtapose the scientific and ethical considerations that are important to consider in rare species protection of plants and animals. We complement previous discussions (Rolston 1985, 2010) by presenting ethical dilemmas of protecting rare species in a Connecticut tidal creek after the immigration of beaver. Our article provides the opportunity to examine the ranking, protecting, and valuing of one species' life over another. We follow with a discussion regarding ethical stances towards the duty to protect rare species and ways of finding common ground between science and ethics during decision-making.

2. ETHICAL DILEMMAS

The ethical dilemmas we present originate from a field survey of Chester Creek, Connecticut for aquatic plants and animals. This survey was conducted by a botanist and Dirrigl in 1995 and 1996 respectively. Chester Creek is a tidal tributary of the Connecticut River and is considered of conservation importance (Nelson and Arnold 1995). The creek flows through Chester township, known as a small, rural town with a quaint downtown attractive to tourists.

The surveys documented the occurrences of an aquatic plant, Parker's pipewort (*Eriocaulon parkeri*), two species of freshwater mussel (tidewater mucket, *Leptodea ochracea*, and Eastern pondmussel, *Ligumia nasuta*), and sea lamprey (*Petromyzon marinus*). Beavers (*Castor canadensis*) constructed a single dam near these species occurrences in 1998. As a result, the physical and biological character of the creek changed (Fig. 1). With the apparent changes, the scientific and ethical dilemma of how to mitigate the impact of the beaver and their dam on Chester Creek became controversial, and conflict ensued among Chester's local government, its residents, and the state regulatory environmental authority: Connecticut Department of Energy and Environmental Protection (CTDEEP). Alternatives to mitigate impacts of the beaver included: 1) allowing the beavers, dam, and resulting changes to remain, 2) installing a water flow control device to mitigate the effect of the beaver dam, 3) live-trapping the beaver, relocating them, and removing the dam, and 4) lethally trapping the beaver and removing the dam. Expectedly, many residents were at

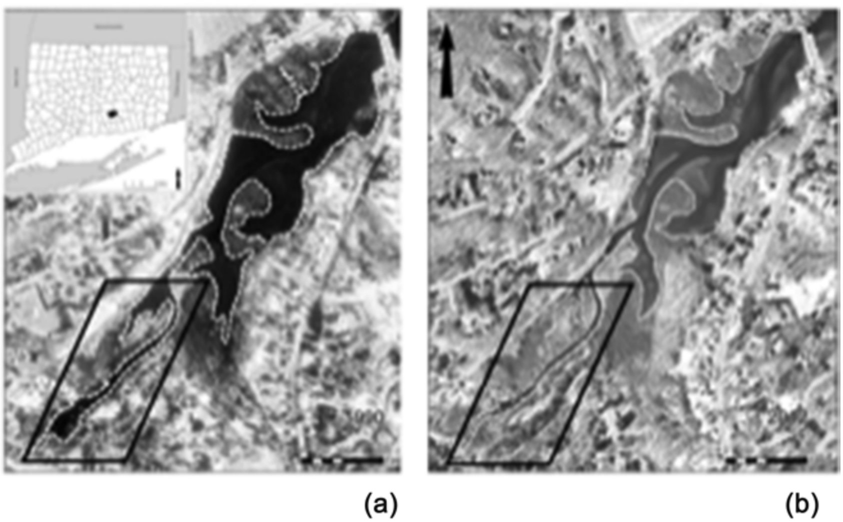

Figure 1. Mapped changes in open water habitat of Chester Creek, Connecticut: (a) 1990 (pre-beaver dam) and (b) 2012 (post-beaver dam). The construction of the beaver dam resulted in a 5% loss (-1,568 sf) of critical waterway (dash line) supporting rare species from the southwest reach to the below the dam. The area of concern is delineated by a solid polygon. Maps created using ArcGIS.

odds with the CTDEEP, who choose option four. Many people understandably were vocal about not harming the beavers. But another concern was that beaver trapping would tarnish the town's character and public perception.

3. SCIENTIFIC CONSIDERATIONS

Scientific considerations regarding rare species protection start with understanding and considering natural history information, which is used by scientists to enact legal protection. We present the relevant scientific information important to consider in deciding the fate of the Chester Creek beaver. Then, we examine rare species protection based on ranking and conservation value.

Parker's pipewort is a small, aquatic plant native to Connecticut that most people would overlook. It is an obligate wetland plant of muddy banks, flats, and marshes, and it requires tidewater flow (Haines 2001). Populations of the plant are annually variable and dependent on environmental conditions. Haines (2001) reported five extant and seven historic occurrences in Connecticut and potential threats. Changes in tidewater flow, river substrate composition, and water inundation all caused by the beaver dam threatened the pipewort's existence. The tidewater mucket is a medium-sized, freshwater mussel found in tidewaters, like the pipewort, and requires substrate bottoms of sand/silt and in variable water depths up to 7.6 m (Strayer and Jirka 1977). The Eastern pondmussel prefers a benthic substrate of fine sand and muds at water depths of 0.3 to 4.5 meters (Strayer and Jirka 1977). Both mussels require stable substrate habitat that was threatened by the beaver dam and its resulting ponding and siltation. The dam also restricted host fish movement, limiting the mussels' ability to disperse in the waterway. The sea lamprey is an anadromous fish that prefers benthic substrate, a stream depth of 11 to 10 cm, and a bottom water velocity of 0.3 to 0.7 m/s (CRASC 2018). The sea lamprey's migration was hindered by the construction of the beaver dam.

The beaver is the largest rodent in North America and is known for the lodges, dams, and ponds they produce. This mammal lives in family groups, established by a pair bond for multiple years, and kits (offspring) remain in the family up to three years old (Busher, Wolff, and Sherman 2007). Beavers were once extirpated (ca. 1900) from Connecticut and the rest of New England, a result of a history of extensive trapping and trade for their fur pelts (Naiman, Johnston, and Kelley 1988). They were reintroduced in 1914 to reestablish the Connecticut population, and have thrived ever since (Wilson 2001). There are positive and negative aspects of beaver immigration to wetlands and watercourses. Long identified by ecologists as a foundation species, beavers create new wildlife habitats supporting a variety of organisms. However, the resulting castorpogenic changes to wetlands and watercourses from beaver dams also include habitat alteration through substrate changes with siltation, reduced water flow and increased water depth, and changes to plant (e.g., vegetation succession) and animal (e.g., replacement of riverine with pond-dwelling species) composition (Burchsted and Daniels 2014).

Natural history information is not only important in determining the rarity of a species but also identifies the critical habitat requirements and specific ecological conditions that are necessary for survival. The pipewort, mussels, and lamprey found in Chester Creek require critical habitat and specific ecological conditions, while the beaver needs only water and tree cambium to eat and survive. Harry W. Greene eloquently describes the essence of the domain of natural history, so important to determining rarity:

> "Natural history focuses on where organisms are and what they do in their environments, including interactions with each other. The building blocks of natural history are descriptive ecology and ethology-detailed accounts of organismal biology in natural settings—followed by experimental studies of factors that affect distribution, abundance, and interactions." (1994, 48)

All of these pieces construct a species' lifeway and are important considerations if species are to be protected and their survival ensured.

4. PROTECTION, RANKING, AND CONSERVATION VALUE OF RARE SPECIES

In the US, the Endangered Species Act of 1973 is the hallmark of the human duty to protect rare plants and animals in light of Anthropocene extinction. A "species" has a right to life and is worthy of protection (Rolston 1985, 1991a). Rare species include those biological and legally determined to be endangered, threatened, or of special concern. These designations are based on the species' range, number of occurrences and population, and known threats to survival. That is, a species with limited range, of low occurrence, with decreasing populations, and is threatened by human actions may be considered rare.

Complimenting the efforts of state and federal rare species protection efforts, The Nature Conservancy in 1979 worked with state environmental protection agencies to establish a network of Natural Heritage Programs, now known as NatureServe (Groves, Klein, and Breden 1995). The continuing goal of this network is to assess rare species and significant natural communities to determine threats and protection needs. Biologists are nationally trained on how to: 1) use species occurrence information to produce population estimations, and 2) apply a ranking method that ought to avoid subjective valuations of a species' rarity by providing a system-wide standardization of terms, definitions, and objective scientific measures (Hammerson et al. 2008). States exchange natural history and occurrence information across this system to coordinate ranking, because species know not of geopolitical boundaries.

NatureServe tracks species using a global status ranking scheme (G–ranks), which range from G5 (secure) to G1 (critically imperiled). Similarly, US states produce associated state status rankings (S–ranks). In Connecticut, the number of occurrences determines a species state rank and whether the species is Endangered (i.e., having five or less occurrences, S1) or Threatened (i.e., having nine or less, S2).

Parker's pipewort is rare plant in New England (Brumback et al. 1996), and during its discovery in Chester Creek, it was ranked S2 (imperiled) and considered a Connecticut State Endangered Species. The plant continues to be rare, currently having a NatureServe rank of S1 (critically imperiled) (NatureServe 2020). Globally (G-ranks), the pipewort is now designated as a G3 species (vulnerable) (NatureServe 2020). The tidewater mucket and eastern pondmussel was during discovery and currently are listed as Species of Special Concern with NatureServe ranks of S2 (Williams et al. 1993, 13). Globally, the tidewater mucket is now ranked a G3 species, and the eastern pondmussel is ranked G4 (apparently secure) (NatureServe 2020). The sea lamprey was at discovery and is currently secure (S5) in Connecticut and globally (G5), however it is identified as a Species of Greatest Conservation Need in the Connecticut River Watershed (CRASC 2018). This fish, however, is not afforded any protection, and personal and commercial fishing for the species is allowed. The beaver is both globally and in the state secure (G5S5), and therefore not considered to be of conservation value and in need of protection. It is also common and ubiquitous in all of New England.

Assessments of conservation value require accurate natural history information to measure diversity, determine rarity, and evaluate human threats. However, the choice of species to be conservation targets can pose ethical dilemmas when one species is ranked higher than another (Minteer and Collins 2005). NatureServe provides a scientifically-based, objective rank calculator. However, the designation and level of threat included in the criteria are human constructs, as is the final determination of a species conservation value and importance. For example, the polar bear is considered to be "intrinsically vulnerable: highly vulnerable" (Master et al. 2012, vii), but the polar bear is not cognitive or worried about this. The polar bear is viewed as vulnerable by scientists, who follow "objective" scientific methods. The objectivity of conservation biology is confounded, because the conservationist "cares" about rare species and is an advocate for their protection, as they should (Shrader-Frechette 1996). Noss argues that it is possible to be "an objective scientist and an advocate for the diversity of life and other normative values at the same time, with no contradiction" (2007, 18). So, scientists need not worry. Scientists as humans also can be "humanistic." This can be accomplished by considering and linking peoples' shared aesthetics, symbolism, cultural heritage, worldview, and ethics, which can allow for a biocultural integration in species protection (Verschuuren 2006; Pungetti et al. 2012). The protection of rare species must go beyond the natural sciences, if its efforts are to be successful.

5. ETHICAL CONSIDERATIONS

Previously, we discussed how science ascribes a value to a species based on a supporting knowledge base of natural history and ranking of rarity. The ranking of a species as rare and designating its conservation value form the basis for enacting timely, needed legal protection. Traditionally, environmental preservationists, such as John Muir, were concerned with protecting nature while promoting a romantic transcendental preservation ethic (Callicott 1986, 1990). Callicott (1980) expands further on the non-anthropocentric views of Aldo Leopold's land ethic to propose that plants and animals possess equal biotic rights. This becomes a central theme in discussions of a species' right to life (Rolston 1991a).

The Chester Creek situation provides distinctive contingencies to address the equality of life among species. Our presentation positions a common animal (beaver) against a rare plant (Parker's pipewort), rare animals (tidewater mucket, eastern pondmussel), and a common animal (lamprey). The ascription of a species' rank of rarity and conservation value is removed from the innate classification of lower versus higher organisms. However, these designations are often perceived differently by non-scientists. The public may have misconceptions and biases towards or against those organisms that are simple (lower), advanced (higher), or 'undesirable'. Even the biology student learning the biological levels of organization from atom to biosphere can ponder: Where not does life begin? but rather, Where does the right to life begin? In the case of rare species, this right to life begins with the organism and not the parts comprising it regardless if the cell is the basic unit of life.

Beyond ethical debates of sentience (Rolston 1991b; Singer 1999), which is not a topic of this paper, lies the question: Does a mussel have the same right to life as a beaver? Scientifically, it could be argued that a lower classified mollusk is perfectly "advanced" in its physiology and anatomical design, which supports an ecological niche that cannot be filled by the higher classified beaver. Nonsensically, a mussel is also more suited to live underwater and in bottom, sandy substrates than a beaver. Such biases are embedded in the traditional evolutionary *tree of life* as exemplified in Haeckel's *The Evolution of Man* (1879) and hierarchicalism (Gould

1996). When the life of a plant is challenging the life of a beaver, a new dimension occurs. The right to life of plants has received much debate with similar arguments and disagreements constructed (Stone 1972; Rolston 1994, 2012; Warnock 2012), and perhaps is rooted in the early anthropomorphism of plants by Darwin (1880). We direct the reader to the many articles that have been written about this topic. Rolston summarizes these sentiments, "Humans should not 'look down on' the 'lower' orders of life, but humans alone can 'look out over' or 'look out for' all other orders of life" (1986, 93). Thus, ethical views towards the equal rights of life among all organisms deserve consideration.

6. THE VALUE OF A RARE SPECIES' LIFE

Contemporary values placed on a plant or animal's life are based on intrinsic and extrinsic factors. Natural law or teleology embeds an *intrinsic* value in a rare species' life that is separate from the *extrinsic* values that ecologists assign to a species based on the role of an organism in an ecosystem (i.e., niche). The intrinsic value of the individual and the species has received much-noted attention and ethical review (Callicott 1980, 1986; O'Neill 1992; Smith 2016).

Individual animals and plants have a good of their own and they defend both their individual lives and their *good-kind* (Rolston 1988). Reproduction is necessary for the fitness of an individual, but an "individual can flourish somatically without reproducing at all" (Rolston 2012, 127). Reproduction may also place an individual in duress and risk, jeopardize energy budget and allocation, and even result in death. By another logic, we can interpret reproduction as the individual's attempt to be recreated by a life history of surviving replacements (Rolston 2012). Rolston proposes that the "locus of the value that is defended over generations is as much in the form of life, since the individuals are genetically impelled to sacrifice themselves in the interests of reproducing their kind" (2012, 127) (i.e., semelparity). For example, annual plants cease after seed production, and some animals die after mating (e.g., spiders, Pacific salmon, *Antichinus* mice). It is the continuation of the species in which the individual is evolutionarily invested.

The species line too is "value-able", able to conserve a biological identity (Rolston 1994, 16). Indeed, it is more real, more value-able than the individual, necessary though individuals are for the continuance of this lineage. As the unit of survival, species must be the focus of protection (Rolston 2012), and endangered species can be considered to possess a higher intrinsic value than common species (Elliot 1992). If the rarity of a species is to be determined, then considering their intrinsic value is just not enough. Biologists protect rare species as part of nature's heritage and human heritage, which establishes a human connection to nature.

The *extrinsic value* of an organism is anthropogenic, and thus a species does not determine its rarity (Rolston 1994). Like the polar bear, an endangered pipewort neither knows of its self-value nor its rarity. Therefore, the determination of rarity requires biologists as evaluators, who make judgments that are extrinsic and subjective. When rarity is used to determine conservation value, an extrinsic value is afforded a species.

Subjective values of plant and animal lives also are viewed through the lenses of non-Western and Western lifeways represented in spirituality and worldviews, in addition to science. For example, Jains observe *ahiṃsā*, a practice that recognizes the protection of all life forms through nonviolence and inflicting minimal suffering and harm (Chapple 2006). Jains avoid animal harm through practices, such as straining water, wearing masks to avoid inhaling insects, and sweeping during walking (Rachels 1983). The first commandment in Buddhist ethics is also *ahiṃsā*, which we regard as the highest reverence towards the lives of organisms practiced by any people.

This respect towards nature is also established in Western lifeways through biocentric ethics. Paul W. Taylor proposes that:

> Once we come to understand its [a butterfly's] life cycle and know the environmental conditions it needs to survive in a healthy state, we have no difficulty in speaking about what is beneficial to it and what might be harmful to it. (1986, 66)

Biocentric ethics allows scientists and non-scientists to share in caring for a rare species' well-being. Expanding on this notion, Horta proposes that biocentric views are compatible with research-based interventions that seek to avoid unnecessary harm (2018). Thus, the evaluation of life can incorporate different sociocultural systems shared by anyone.

The value and affinity afforded a rare species is also dependent on a person's perception and attitude towards it (Kellert 1985). Public affinity towards a plant or animal can be influenced by media coverage. In newspapers, the Chester Creek dilemma was slanted in favor of the beavers (Dee 2000a, 2000b). Additionally, media coverage of plants and animals tend to focus on showy, beautiful flowering plants (e.g., orchids) or furry, cute animals (e.g., beavers). If instead of the pipewort, the beavers' lives were threatened by non-photogenic, Connecticut rare tabanid flies, it could be expected that even more public discontent would have occurred. A different dynamic might also have arisen if instead the creek was located in Oregon or New York, where the beaver is the State Mammal/Animal and of cultural and historical heritage. Conservationists are also guilty of showing off pleasing-looking species, such as the Texas state-endangered ocelot (*Leopardus pardalis*), to raise awareness in protecting biodiversity. Is not the threatened Coues' rice rat (*Oryzomys couesi*) found in the state equally as furry and cute and deserving of public empathy (cf., Panagiotarakou 2020)?

7. THE MORAL DUTY TO PROTECT AND PREVENT HARM TO RARE SPECIES

Environmental ethics establishes a human responsibility and moral duty to protect nature regardless of the benefits of plants and animals to people (i.e., normative ethics) (Callicott 1980). Changes to the freshwater tidal wetland of Chester Creek were evident with the establishment of the beaver dam. The scientific and local community of Chester shared a duty to protect the rare species found before the beavers' arrival, and to be "stewards" of the creek (c.f., stewardship management) and the plants and animals living in it. Everyone shared a common human interest in protecting nature.

It has been argued that people share an affinity towards nature whether embedded in their worldview or expressed through a biological affinity (i.e., biophilia) (Kellert and Wilson 1993). Thus, "one's belief about nature, which is based upon but exceeds science, has everything to do with beliefs about duty" (Rolston 1991a, 95). The duty to protect is to prevent "harm," defined by the government as, "to include any act which actually kills or injures fish or wildlife", and emphasizes that such acts may include "significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife." (Federal Register 1999, 60731) The difference is in the duties expected, obligated, or taken on by governmental agents, scientists, and the public.

However, how can the harm to one species over another be justified? Each species possesses unique genetic material and ecological character. For example, the existence of a keystone species is vital to maintaining the ecosystemic pyramid (Rolston 2012). So, should protection be afforded only to exceptional forms? One should consider rarity, for killing individuals of a common species does not place the species or their evolutionary lineage in peril, because the genome will persist in closely related genera. Losses of individuals of a rare species, however, can affect the survival of a rare species by reducing the minimum viable population (Soulé 1987). Unequal conservation efforts between agencies and NGOs (e.g., Save the Florida Panther Day) often exist but raise the question: Is saving the endangered Florida panther (*Felis concolor coryi*) more important than the endangered Miami tiger beetle (*Cicindelidia floridana*)? We find value in and have duties toward them all, though perhaps not with equal intensity over them all, in view of varied taxonomic levels of development.

A profound difference exists among extinction, extirpation, and removal of a population of an organism. Rolston equates extinction with "superkilling" and the ceasing of generative processes (1985, 723). He explains that extinction collectively kills forms (species) beyond individuals and not just distributively (i.e., extirpation). Rolston expands the notion of killing:

> "To kill a particular animal is to stop a life of a few years or decades, while other lives of such kind continue unabated; to superkill a particular species is to shut down a story of many millennia, and leave no future possibilities." (2010, 206)

That is why killing the last of a rare species is strongly prohibited legally and morally. You are not just killing a "token of a type," you are killing the last tokens of that type and therefore killing the type (Rolston 1985, 722). Extinction is forever. What if Dirrigl's (1994) capture of three least shrew (*Cryptotis parva*) voucher specimens in Connecticut resulted in the taking of the last ones, resulting in the *extirpation* of the species in Connecticut, and all before it could be considered as the state's only endangered mammal? Would it be defensible if he explained that the killing did not cause *extinction*, and that an owl would eat more than three shrews like they eat voles in a single night anyway (Glue 1967)?

Beavers in many states, such as Connecticut, were extirpated historically, but thrive today through early 20th Century introduction and relocation efforts by conservationists. Should humans intervene to control the damage poised by beavers in Chester Creek? Should not humans abstain from interfering in the natural succession of an ecosystem, the so-called let "nature take its course" approach? Society is obligated to intervene on the behalf of rare species in regions impacted greatly by urban commercial and residential development. Development can involve watercourse diversion, wetland draining and filling, and even the creation of artificial ponds for water retention or recreation. As trees are cut down and the ecosystem is disrupted either temporarily, short-term, or permanently, animals such as beavers are displaced. In circumstances of disrupted environmental conditions, habitat loss, and displacement, it is natural for beavers to seek refuge in other watercourses. Perhaps one of those circumstances caused beavers to build a dam in Chester Creek. No matter, the beavers' fate was decided by the CTDEEP, following their statewide beaver management program (Wilson 2001). Did the beavers even have a chance?

8. MANAGING BEAVER AND MANAGING RARE SPECIES

In 1999, the CTDEEP authorized lethal beaver trapping of two adults and three kits in Chester Creek, a single kit escaped capture (Dee 2000a). The position of the CTDEEP is that nuisance beavers shall be trapped rather than relocated and dams removed, although initial mitigation may include the installation of water flow devices. However, water flow devices, dam removal, and pond draining are only temporary solutions to the physical and biotic changes resulting from beavers creating ponds. Capturing and transporting beavers to other areas does not seem to help, and it just causes a dam to be built elsewhere, possibly causing another dilemma. It is also impractical; the CTDEEP Wildlife Division receives an annual average of 145 beaver complaints associated with flooding and damage (Werth 2019). The CTDEEP's justification for their decision to trap the Chester Creek beaver included that the dam: 1) posed a threat to a residential septic system, 2) impeded anadromous and catadromous migratory fish, 3) interfered with the tidal creek's lunar ebb and flow and affected water depth (i.e., the water rose two feet), and 4) threatened the survival of an occurrence of a Connecticut state endangered plant, the Parker's pipewort (Dee 2000b). Noteworthy, the occurrence of the freshwater mussels, both Connecticut Species of Special Concern, was not included in the justification reported in the news or even their discovery ever mentioned by the press.

9. SEEKING A COMMON GROUND IN RARE SPECIES PROTECTION: POLICY RECOMMENDATIONS

The castorpogenic changes to Chester Creek raised awareness of the need for rigorous stewardship of natural areas of biocultural value among all stakeholders. They all desired to protect Chester Creek and to preserve its biodiversity. Stakeholders involved in the dilemma to save or kill the beavers included, but were not limited to: the Chester Residents for the Environment and Wildlife (an NGO created in response, but now disbanded with no internet presence), a beaver consultant, environmentalists, the Chester Land Trust and Carini Preserve Management Committee, Town of Chester, and the CTDEEP. Among all, there occurred a high concern towards the fate of the beaver. This concern led to the community requesting a meeting with the CTDEEP, which was held approximately three months post-killing in 2000. It was at this untimely meeting that the agency presented its scientific and legal justification for the decision it made. However, holding a meeting after a decision is made does little to invoke public trust and confidence in local and state governmental agencies.

Conservation initiatives and protection measures can be more successful with the inclusion of social scientists (Mascia et al. 2003; Bennett et al. 2017). We assert that stakeholders should seek assistance from a "conservation mediator" (CM), which ideally has dual education and training in the natural and social sciences. The goals of the CM are at the least fivefold. First, the CM ensures that a balanced exchange of ideas takes place during meetings. This is vital to avoid stakeholders from feeling intimidated by science. For example, a CM can raise the relevance of folk knowledge, shared history, and citizen science by facilitating dialog among stakeholders.

Secondly, the CM provides, when needed, suitable explanations, which can be understood by all and avoid scientific jargon and abbreviations. Most stakeholders and even biology majors, unless having completed an invertebrate zoology, parasitology, or ichthyology course, likely would not be familiar with terms, such as glochidia or periostracum, relating to the natural history of freshwater mussels. Few people, except those trained by NatureServe, would likely recognize the abbreviation EO, or element occurrence, so important to tracking populations of rare species and determining rank.

Thirdly, the CM maintains the biocultural relevance of issues between parties. Brown et al. (2004) demonstrated the linkage and complementary strengths of public and scientific perceptions of biological value and importance.

Fourth, the CM upholds a meeting atmosphere that allows for respectful and leveled presentations of ideas and discourse among stakeholders. A CM also can ensure that all meetings are held in a place and time that encourages public participation. For example, a governmental meeting, mid-day and during the workweek, in an uncommon location, and that lacks signage, does little to entrust the community in government agencies as witnessed by Dirrigl in Texas.

Lastly, the CM appeals to all sides, which can feel comfortable working with someone they can relate to. Unfortunately, in the absence of a CM, the possibility exists of some stakeholders feeling intimidated by government officials with their scientific backgrounds. With their appreciation, understanding, and embracement of the sociocultural differences among stakeholders, a CM is in the unique position to assist in finding a common ground agreeable by consensus. The Chester Creek situation would have benefited by adopting the use of a CM and seeking early engagement among all stakeholders about the issues before the fate of the beaver was decided by the CTDEEP.

The desire for community action by stakeholders provides the chance to participate in biomonitoring, however citizen science training should be provided. Land stewardship planning and management should include active biomonitoring. On learning about the rare species occurring in Chester Creek and near the Carini Preserve, The Chester Land Trust perhaps could have watched for the early signs of castropogenic changes to the critical habitat and raised immediate awareness of the threats faced by the pipewort, mussels, and sea lamprey. Likewise, the CTDEEP, who knew in 1995 and 1996 that the rare species occurred, could have coordinated biomonitoring of the locales before the 1998 immigration of beaver. Unfortunately, before it was too late and only after the meeting took place did citizens express a desire to begin monitoring the beavers and offered to discourage future beaver activity by removing dam debris (Hesselberg

2000). A vital part of land stewardship, particularly parcels supporting rare species and associated critical habitat is active biomonitoring. The Chester Creek dilemma continues to offer a valuable lesson to head by all, but what lessons can be learned?

10. CONCLUSIONS

Our discussion details how scientific and ethical considerations apply to rare species protection. If these considerations are ignored, it is expected that similar ethical dilemmas and consequences will continue to occur, which can lead to a match between the science of rare species protection against the public's ethical views toward preventing harm. But is it possible to avoid the dilemma of valuing one species life over that of another and having to determine which species has a greater right to life? After the discovery of Parker's pipewort, the two freshwater mussels, and sea lamprey inhabiting Chester Creek, vigilant land stewardship should have been implemented through citizen science and by the CTDEEP. In this scenario, adaptive management (e.g., installing a flow control device and evaluating its effectiveness) could have taken place before the physical and biological character of the waterway changed. These actions are even more important today in light of recent beaver management challenges in other Connecticut towns (see Werth 2019). Overall, the following questions are fundamental to the scientific and ethical considerations of protecting rare species, whether in Chester Creek, Connecticut, or anywhere else:

- Is the necessary scientific knowledge and natural history information available to guide decision-making?
- How should a rare species be valued?
- Who should the evaluators of life be?
- Has the sociocultural and ethical bases shared among stakeholders been recognized and considered?
- What is the duty to protect rare species, and who shares in this responsibility?
- Has the opportunity for open discussion among stakeholders been provided?
- Has a conservation mediator been sought to help with facilitating dialogue among stakeholders?
- Have all the steps to avoid harm been evaluated and attempted before killing?
- What is the justification for any decision-making and/or actions taken? And if any actions fail, are all stakeholders open to finding another solution (i.e., adaptive management)?

We feel it is imperative that the scientific and ethical considerations of rare species protection involve knowledge contributed by both the scientific community and the public. Including the public through citizen science has proven successful in gathering the important natural history data of plants and animals and forming alliances among people sharing a similar environmental ethic. This is evident by the successes of citizen science and biomonitoring on federal lands (e.g., National Park Service's Dragonfly Mercury Program), bioblitzes, and even through environmental education. However, natural history information may be disproportionate among rare species. For example, the knowledge about beaver is greater than about Parker's pipewort, and Haines' report (2001) about the plant became available six years after the plant's discovery in Chester Creek. This can hinder the development of conservation management plans and protection measures.

We recognize the ethical considerations of species protection, favoring a reliance on *extrinsic* values. The extrinsic value assigned to an organism forms a measurable basis for determining species protection, and it has a greater practical application. Thus, we support the multiple criteria and practical approach of NatureServe's ranking scheme for its detailed standardization to determine the rarity and conservation value of plant and animal occurrences. Whether a species value is objectively or subjectively determined is not as imperative as the consequences that the valuation may have in the survival of an organism. Beaver are a common species, nowhere near being state-wide or nationally endangered, threatened, or of special concern. Historically, they were extirpated by trappers to sell their fur, but beaver trapping has not been a worry for many decades and is still legally allowed through permitting. Ramp and Bekoff (2015) propose that there is a place for compassion in conservation, but also recognize the necessity of "triage" to protect imperiled species.

We implore the adoption of our CM concept to reach a desired common ground in face of environmental ethical dilemmas. Our illustration of the beaver trapping in Chester Creek to protect rare species exemplifies the dilemma faced by scientists and the public, particularly when the life of one organism is in jeopardy over that of another. By working with a CM, a different dimension and atmosphere are possible that would allow for the civil exchange of ideas in public meetings. Although not everyone may be happy with a decision and outcomes, a respect for sociocultural ideals is possible to maintain.

We are concerned with the duty to protect rare species, avoid harm if possible, and for decisions regarding a species' life to be based on defendable justifications. Never before has the need for scientists to inform the public of their knowledge and justify their decision-making been so important (Priest, Goodwin, and Hooke 2018). We urge that decisions regarding the lives of species to: 1) involve respect for plant and animal life, 2) seek to avoid harm or reduce it, and 3) choose harm only as a last resort after considering all alternatives. It is the CTDEEP's duty and role to equally protect all federally and state-listed endangered and threatened species. To protect the rare species found in Chester Creek, the CTDEEP left those stakeholders desiring no harm to the beaver with no favorable solutions or alternatives. The beavers had to be trapped and the dam destroyed. For the beavers of Chester Creek, it was too late to consider alternatives and actions, and thus the CTDEEP took protective actions toward the rare species. We urge that solutions to beaver management be creative, implement timely solutions, and allow for adaptive management. John Hadidian reflects this sentiment:

> The future of beaver management will lie in new perspectives generated from a better understanding of these animals, their populations, their communities, and the ecosystem which they are a key part. Animal welfare interests cannot expect that or demand that every human-beaver conflict be resolved by nonlethal means, only that they be resolved humanely. (2003, 221)

Our evaluation of the scientific and ethical considerations regarding the Chester Creek beaver dilemma leads us to support the decision, justifications, and actions of the CTDEEP to kill the beaver. The castropogenic changes to Chester Creek were rapid and drastically threatened the critical habitat required for the survival of Parker's pipewort, tidewater mucket, Eastern pondmussel, and sea lamprey. Although the environmental changes to a watercourse resulting from beaver activity may be possible to repair, the replacement of critical habitat supporting a rare species is not. Even more difficult, but not impossible, are rare plant and animal restoration efforts, and aquatic habitat and species are most vulnerable and difficult to restore. Whereas the killing of five beavers posed harm, it involved no threat to the survival of the species in Connecticut or elsewhere. It was unfortunate but justifiable. We justifiably ought to protect and save vulnerable, rare species as part of an "ecological ethic" (Rolston 1975), when their survival is jeopardized by other organisms that are objectively or subjectively determined to be invasive, non-native, or nuisance species, even if this means killing a common species, such as beaver, as a last resort.

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