5-2017

A framework for evaluating and enhancing resilience integration in conservation policy: The case of Massachusetts

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May 2017

A Master's Paper
Submitted to the faculty of Clark University, Worcester,
Massachusetts, in partial fulfillment of the requirements for the degree of Master of Arts
in the department of Environmental Science & Policy
And accepted on the recommendation of
Gregory Trencher, Chief Instructor

Abstract

An evaluative framework for evaluating and enhancing resilience integration in conservation policy for Massachusetts

Kyle Pilkington

This paper develops a framework for evaluating conservation policy from the perspective of integrating resilience, using Massachusetts as a case study. After an intensive literature review on the topics of resilience and conservation, five resilience-enhancing attributes were identified: biodiversity, stakeholder engagement, acknowledgement of climate change, multiple species or species interaction focus and ecosystem or environment health. The framework ranks the policies with respect to the effectiveness of following the resilience-enhancing attributes. Three Massachusetts-based conservation policies, Massachusetts Endangered Species Act (MESA), State Wildlife Action Plan (SWAP) and MassWildlife Habitat Management Grant Program (MHMGP), were chosen to demonstrate the evaluative capacity of the framework. The evaluation gave equal rankings to MHMGP and SWAP for the integration of resilience into their policies. MESA received the lowest ranking of the three policies analyzed. This framework was designed as a tool that can be used for any type of conservation policy. It will evaluate and rank those policies based on their ability to integrate resilience. In turn, this can improve conservation policies through resilience against the negative effects of climate change.

Gregory Trencher, Ph.D.
Chief Instructor

Academic History

Kyle Daniel Pilkington **May 2017**

Baccalaureate Degree: Environmental Science
Source: Union College **June 2014**

Acknowledgements

I wish to thank Professor Gregory Trencher, for his support of this research and for his guidance for the completion of this paper.

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Criteria	Reasoning	Key References
1. Emphasis on biodiversity		Goerner et al., 2009; Hodgson et al., 2009
Does the policy make conservation of biodiversity a priority?	Higher levels of biodiversity result in a more resilient ecosystem	
2. Stakeholder engagement		Crabbe, 2010; Jolibert & Wesselink, 2012; Pullin & Stewart, 2006
Does the policy incorporate stakeholders throughout the process?	Increased levels of stakeholder engagement lead to better success of scientific projects Transparency, open communication fosters trust between stakeholders	
2.1. Diversity of actors represented		
Are all those affected by the policy included in the process?	Support from stakeholders will help with the success of the project	
2.2. Concrete actions to allow co-implementation of strategies		
Does the policy outline action for stakeholders to be involved?	Legal documentation of expectation and commitment of stakeholders will make them more invested in the projects success	
3. Acknowledgement of climate change		Mawdsley et al., 2009; Hannah et al., 2002; Hodgson et al., 2009; Lin, 2011
Does the policy recognize the danger climate change poses?	Formal declaration of climate change as a threat to conservation leads to improved preparation of conservation action	
3.1 Use of phrase "climate change"		
Does the policy use the term climate change in its documentation?	Climate change needs to be formally acknowledged before action can be taken	
3.2 Climate change as a threat to conservation		
Does the policy recognize the threat climate change poses to conservation?	Climate change is a threat to conservation that needs to be addressed	
4. Multiple species or species interaction focus		Soule et al., 2005; Fogarty & Rose, 2014; Goerner et al., 2009
Does the policy focus on strategies other than single species conservation?	Multiple species conservation affects a larger number of species, bolstering biodiversity and resilience	
4.1. Emphasis on keystone species		
Does the policy emphasis keystone species?	Keystone species affect multiple trophic levels and conservation of them can help bolster biodiversity	
5. Ecosystem and environment health		Walker, 1995; Fogarty & Rose, 2014
Does the policy consider conservation of the ecosystem rather than species?	A resilient ecosystem mitigates the negative effects of climate change Improve the quality and quantity of resources available in an ecosystem	

Table 2: Characteristics of the surveyed conservation policies

Policy	Year introduced (Last update)	Direct target	Actions prevented	Function
Massachusetts Endangered Species Act	1990 (2010)	Endangered plant or animal species	"Take" or any harm against listed endangered species	Legal protection of listed endangered species
State Wildlife Action Plan	2005 (2015)	Endangered species, habitat, general conservation	Loss of endangered species and habitat	General conservation outline for MA
MassWildlife Habitat Management Grant Program	2016	Habitat conservation	Loss of habitat	Financial assistance for habitat restoration or conservation

Table 3: Evaluation results of three surveyed policies

Resilience-Enhancing Traits	Massachusetts Endangered Species Act (MESA)	State Wildlife Action Plan (SWAP)	MassWildlife Habitat Management Grant Program (MHMGP)
Emphasis on biodiversity	-	+ + +	-
Stakeholder engagement			
Diversity of actors represented	+ +	+ + +	+ + +
Concrete actions to allow co-implementation of strategies	+	-	+ + +
Acknowledgement of climate change			
Use of phrase “climate change”	-	+ + +	-
Climate change as a threat to conservation	-	+ +	+
Multiple species or species interaction focus	-	+	-
Emphasis on keystone species	-	+	-
Ecosystem and environment health	+	+	+ + +
Total	-	+ + +	+ +

1. Introduction

We are currently experiencing the sixth mass extinction event in the history of Earth. In contrast to the other mass extinctions, humanity is the major cause (Barnosky et al., 2011). We have increased the extinction rate of species between 100 to 1,000 times above natural levels (Rockström et al., 2009). Natural extinction rates, according to the fossil record, are 0.1 to 1 extinctions/year per million species. We have increased that to ≥100 extinctions/year per million. In addition to destruction of natural habitat from agriculture and urbanization, a major driver for this rapid rise in extinction rates is the rapid influx of greenhouse emissions into the atmosphere various anthropogenic activities (IPCC, 2014). Just some of the devastating effects of climate change include sea level rise, temperature increase and precipitation change (IPCC, 2014). If our conservation continues in a business as usual fashion then we will bear witness to the continued loss of innumerable of species. Rapid onset of anthropogenic climate change will destroy entire ecosystems and threaten millions of species globally (Wake & Vredenburg, 2008).

The human act of conservation was designed to protect any species, plant or animal, and ecosystems threatened by us. Conservation policies dictate what action is taken and how to manage these endangered species and ecosystems. In spite of an increased focus on conservation, many of these policies are outdated because they fail to address the concept of resilience in relation to a rapidly changing climate (Fischer et al., 2009). New methodologies of conservation are needed that focus on enhancing resilience within ecosystems (Mcclanahan et al., 2008). These methodologies can be utilized by both conservation policies and in management. This focus on resilience will protect ecosystems and species against the negative impacts of climate change.

An evaluative tool is needed to assess conservation policy and the extent to which they integrate principles and strategies relevant to climate change and enhancing resilience. This tool accounts for the multitude of different variations of conservation policy. At the federal level of the United States, the Endangered Species Act dominates conservation action. Each state also has their own set of conservation policies and resulting management strategies. However, these conservation policies are not prepared to protect their endangered species against the threat of climate change

(Hannah et al., 2002). No evaluative framework currently exists for the objective evaluation to the degree by which policies and conservation action incorporate resilience. If such a framework existed, it would allow us to categorize, rank and subsequently improve existing conservation policies. It would help to ensure that resilience-enhancing attributes are applied to protect ecosystems and species against the negative effects of climate change.

Resilience is a complex word with multiple definitions and meaning, depending on who is using it and what they hope to achieve. It has become a buzzword, like sustainability or adaptation. Therefore it is immensely important to clearly define resilience. Resilience is not a contemporary idea. It has been used in the fields of ecology and other natural sciences for several decades. Our first understandings of resilience described it as the capacity of systems to absorb changes in state variables and the persistence in quality of relationships maintained within that system (Holling, 1973). This ensures some variability within a given system and allows it to withstand a certain degree of change and still remain functional. Modern definitions of resilience are remarkably similar. Resilience seeks to measure a system's ability to survive and persist within a variable environment (Zoghbi, 2014). Essentially, it means that a more resilient a system can withstand larger disturbances without collapsing or shifting to an entirely different system (Walker et al., 2006). The definition has remained largely unchanged during the intervening decades, but its use has become more widespread. It has worked its way into other systems outside the field of ecology. Social resilience is the ability of groups to deal with external stress as a result of social, political or environment change (Zoghbi, 2014). It has even been used in the field of economics to describe the probability of state (or system) transition as a function of consumption and production (Zoghbi, 2014). We refer here exclusively to the ecological definition of resilience. The system described may refer to entire ecosystems, or particular species.

In terms of conservation, we can achieve greater resilience for an ecosystem by increasing biodiversity (Goerner et al., 2009). If an ecosystem is remarkably efficient, in terms of energy transfer between trophic levels, there are a limited number of species responsible. If one or a few of these species were to go extinct, due to external or internal factors, the entire trophic system would collapse (Goerner et al., 2009).

Ecosystems that are resilient have many species responsible for the transfer of energy between trophic levels. If one or more of these species were to go extinct, then the entire system would be weakened, but remain intact because other species are still transferring energy between trophic levels to (Goerner et al., 2009). Therefore, our best hope at fostering resilience in endangered species and ecosystems is to protect biodiversity. A greater resilience in our ecosystems will increase the capacity of that system to withstand the negative effects associated with climate change. Yet, currently, resilience is not well incorporated into our conservation policies (Mawdsley et al., 2009, Hannah et al., 2002). By integrating resilience into conservation policy we can ensure the protection of species and ecosystems as the planet undergoes a rapid shift in climate.

There is very little material linking the topics of resilience and conservation policy together in a cohesive fashion. Other evaluative frameworks look towards sustainability, or other types of environmental policies (Lafferty & Hovden, 2003; Wolfram, 2016). Often these policies even deal with the topic of resilience and expertly relate it to concepts like sustainability (Wolfram, 2016). However there are no frameworks that yet deal with the topic of resilience and its relation to the field of conservation.

This paper seeks to develop an evaluative framework to measure resilience-enhancing attributes. This framework will be applied to three conservation policies from the state of Massachusetts. These examples will demonstrate the practical value of the framework as an analytical tool that could be applicable to other conservation policies outside of Massachusetts. The evaluative framework was developed from academic literature regarding the relationship between resilience and conservation. Five resilience-enhancing attributes are outlined within the framework. The three policies, the Massachusetts Endangered Species Act (MESA), State Wildlife Action Plan (SWAP) and MassWildlife Habitat Management Grant Program (MHMGH) were selected because of their direct involvement with statewide conservation.

This paper is structured as follows. Firstly, it details the necessary background information needed to understand the importance of incorporating resilience into conservation. It then describes the development of the evaluative framework that is

applied to evaluate three MA conservation policies in the findings section. Finally, based on the results of this evaluation exercise, this paper will make some recommendations for improving of conservation policies.

2. Theoretical Perspectives

Contemporary Conservation Practices

Conservation policy determines what action we can take on the behalf of endangered species and ecosystems. Ideally, it encourages beneficial practices, such as a creation of protected habitat for an endangered species. It also prevents certain actions, such as hunting an endangered species. Although there are some exceptions, generally, our current models of conservation integrate resilience poorly (Mawdsley et al., 2009; Hannah et al., 2002). Environmental management still tends to focus on single species conservation (Soule et al., 2005; Fogarty & Rose, 2014). These actions view species in isolation within their ecosystem. Since this approach fails to protect other species and preserve biodiversity, this practice does not promote resilience for the ecosystem.

Current management strategies that seek to conserve habitats or ecosystems tend to have greater resilience-enhancing tendencies. Implementation of ecosystem-based management systems has been slow and tedious (Fogarty & Rose, 2014). Apart from these ecosystem-based management systems, there are other conservation strategies utilized today that emphasis resilience. These include prevention of habitat fragmentation, increasing connectivity between already fragmented habitats and a concentrated effort on the conservation of keystone species (Noss, 2001; Hodgson et al., 2009). Habitat protection helps to conserve the entire system, but a focus on keystone species is particularly important. A keystone species has a great effect on the rest of its ecosystem. These interactions force a slight benefit of resilience-enhancing attributes. A few examples of the effect that keystones species have on their environment are sea otter populations in the Pacific Northwest that stimulated the growth of kelp forests, in turn providing a haven for coastal biodiversity (Soule et al., 2005). Other species like the prairie dog decrease densities of woody shrubs and increase densities of grasses for large grazing species, thereby increasing plant productivity (Soule et al., 2005).

Perhaps the most well studied keystone species of North America is the grey wolf. Its reintroduction into Yellowstone National Park has had enormous, well-documented, physical and biophysical effects within that ecosystem (Soule et al., 2005).

Just one of its many effects was an increase in scavenging biomass, left over from various wolf hunts (Wilmers et al., 2003). This increase biomass led to an increase in the biodiversity of other scavenging species (Wilmers et al., 2003). As argued, greater biodiversity in any ecosystem results in greater resilience (Goerner et al., 2009). In this case, single species conservation of the grey wolf benefited the entire ecosystem of Yellowstone National Park. The presence of a keystone species can have great benefits (and consequences) for the other species in the ecosystem (Soule et al., 2005). Conservation strategies that focus on these species would be of particular importance in fostering resilience.

Climate Change

Our climate is changing on a scale that has never before occurred. The warming of our climate is unequivocal, and beginning in the 1950s, our observed changes are unprecedented over decades to millennia (IPCC, 2014). Our average global surface temperature, as calculated by a linear trend, has increased 0.9°C from since 1880 (NASA, 2017). Following this trend, the temperature of the surface area of the ocean has warmed by 0.11°C every decade since 1971 (IPCC, 2014). Sea level has risen 0.19 m from 1910 to 2010 (IPCC, 2014). These and other changes have the potential to further accelerate the extinction of millions of species globally (Wake & Vredenburg, 2008).

Massachusetts is not immune to the effects of climate change and is already undergoing changes. Temperature for the state has increased by approximately 1°C since 1970 and sea surface temperature has increased by 1.3°C (EEA, 2011). Sea level has risen 22 cm between 1921 and 2006 (EEA, 2011). By 2100, according to the high emissions scenario of the IPCC, Massachusetts will experience a 3°C to 5°C increase in average temperature (EEA, 2011). This includes days with temperatures greater than 32°C increasing from 5 to 20 days annually and as many as 28 days annually are predicted to reach above 38°C (Frumhoff et al., 2006, Frumhoff et al., 2007). Winter precipitation is expected to increase by 12% to 30%, through the form of rain (EEA, 2011). The overall number of snow events will decrease from 5 each month to 1-3 each month (Hayhoe et al., 2006). An 8% increase in extreme precipitation

events is expected for the northeastern U.S. by 2050, rising as high as 13% rise by the end of century (EEA, 2011). Rainfall during the wettest 5-day period of every year is expected to increase by 10% by 2050 and by 20% by the end of the century (Frumhoff et al., 2006, Frumhoff et al., 2007).

While these changes are expected to have a devastating effect on humanity, the effects for wildlife and biodiversity are expected to be even more severe. Our current models of conservation fail to properly address the need to adapt to such a rapidly changing climate (Mawsdley et al., 2009, Hannah et al., 2002, Hodgson et al., 2009). Conservation is spoken about in terms of adaptation through measures like the maintenance of genetic diversity, community-based natural resource management and reduction of habitat fragmentation (IPCC, 2014). Elsewhere, increased connectivity between habitats has become the primary focus (Hodgson et al., 2009). Resilience is rarely considered. Global climate change is expected to have an incredibly destructive and myriad of effects upon wildlife and ecosystems. Non-exhaustively these include a shift in species distribution (especially along elevation gradients), changes in the timing of life-history events of particular species (spawning, migration, etc.) decoupling of coevolved interactions (plant–pollinator relationships), effects on demographic (survival, fecundity, etc.), reductions in population size (especially boreal or alpine species) (Mawdsley et al., 2009). Other impacts will encompass extinction or extirpation of range-restricted or isolated species and populations, direct habitat loss due to sea-level rise, increased fire frequency, altered weather patterns, glacial recession and direct warming of habitats, increased spread of wildlife diseases and parasites, and increased populations of species that are direct competitors of focal species for conservation efforts (Mawdsley et al., 2009). The largest threats to Massachusetts's ecosystems and species populations are the loss of habitat and ecosystem function caused by development, fragmentation, invasive species, or other threats (EEA, 2011). These threats will be exacerbated by climate change. Resilience and conservation of biodiversity should be emphasized as the primary focus for conservation work (Hodgson et al., 2009). This will be the most effective method of conservation in the face of a rapidly changing climate.

3. Methods

3.1 Study Design

This paper set out to develop an evaluative framework that could assess the extent to which a set of resilience-enhancing attributes is present within a selection of conservation policies. It was constructed from insights gained by a comprehensive literature review on the role of resilience in conservation action. To demonstrate the potential of the evaluative framework, three conservation policies from Massachusetts were selected. These policies were evaluated using the framework to identify gaps in resilience-enhancing attributes. Once these gaps had been determined, recommendations (based on insight gained from the literature review) were suggested to improve the resilience-enhancing nature of these policies. The evaluative framework was designed for conservation policy on any level of government, whether state or federal. However, it could also be applied to rules or regulations within an NGO or other private conservation organization. The framework was also designed to be simple enough that it could be utilized by policy makers, academics or members the public.

3.2 Data Collection

Data for building the evaluative framework was collected from a literature search. This was conducted over the period from March 2016 to November 2016, with additional sources added as work progressed. Information was accrued slowly, building a vast base of information in the fields of conservation, policy and the role of resilience. Most sources came from peer reviewed academic journals on the topics of resilience in conservation. These were obtained using Google Scholar, Web of Science and Clark Library Database. Keyword searches included variations on the phrase “resilience in conservation policy” and “resilience conservation” or other words related to resilience and conservation. These sources were screened to identify the most relevant academic papers and to exclude those deemed extraneous. Care was given to ensure that number of citations and most recent publications were considered as items of particular importance. Approximately ten sources were used in the construction of the evaluative framework and the five resilience-enhancing attributes. In total, over 35 references were utilized in the construction of this paper.

The conservation policies were surveyed directly from the Massachusetts legislature. The primary source of these policies was the Department of Energy and Environmental Affairs <mass.gov> website. For selection, review of the various conservation policies in effect was undertaken. No additional third party sources, or analysis of these policies was examined, merely the policies themselves. NGO's or other conservation organizations were not considered as contributors to policies, but were reviewed when during the literature search on resilience.

3.3 Explanation of Evaluative Framework

This evaluative framework was developed to assess the integration of a set of five resilience-enhancing attributes within various conservation policies. The five attributes are biodiversity, stakeholder engagement, acknowledgement of climate change, multiple species or species interaction focus and ecosystem or environment health. Its construction was the result of an intensive literature review on the role of resilience in conservation. Each of the five attributes of the framework will be explained in greater detail in the following sections.

Table 1: Evaluative framework developed for assessing resilience-enhancing attributes in conservation policy

Criteria	Reasoning	Key References
1. Emphasis on biodiversity		Goerner et al., 2009; Hodgson et al., 2009
Does the policy make conservation of biodiversity a priority?	Higher levels of biodiversity result in a more resilient ecosystem	
2. Stakeholder engagement		
Does the policy incorporate stakeholders throughout the process?	Increased levels of stakeholder engagement lead to better success of scientific projects Transparency, open communication fosters trust between stakeholders	Crabbe, 2010; Jolibert & Wesselink, 2012; Pullin & Stewart, 2006
2.1. Diversity of actors represented		
Are all those affected by the policy included in the process?	Support from stakeholders will help with the success of the project	
2.2. Concrete actions to allow co-implementation of strategies		
Does the policy outline action for stakeholders to be involved?	Legal documentation of expectation and commitment of stakeholders will make them more invested in the projects success	
3. Acknowledgement of climate change		Mawdsley et al., 2009; Hannah et al., 2002; Hodgson et al., 2009; Lin, 2011
Does the policy recognize the danger climate change poses?	Formal declaration of climate change as a threat to conservation leads to improved preparation of conservation action	
3.1 Use of phrase "climate change"		
Does the policy use the term climate change in its documentation?	Climate change needs to be formally acknowledged before action can be taken	
3.2 Climate change as a threat to conservation		
Does the policy recognize the threat climate change poses to conservation?	Climate change is a threat to conservation that needs to be addressed	
4. Multiple species or species interaction focus		Soule et al., 2005; Fogarty & Rose, 2014; Goerner et al., 2009
Does the policy focus on strategies other than single species conservation?	Multiple species conservation affects a larger number of species, bolstering biodiversity and resilience	
4.1. Emphasis on keystone species		
Does the policy emphasis keystone species?	Keystone species affect multiple trophic levels and conservation of them can help bolster biodiversity	
5. Ecosystem and environment health		Walker, 1995; Fogarty & Rose, 2014
Does the policy consider conservation of the ecosystem rather than species?	A resilient ecosystem mitigates the negative effects of climate change Improve the quality and quantity of resources available in an ecosystem	

Emphasis on biodiversity

Conservation policies must emphasize biodiversity as an important factor if they are to create resilient ecosystems. As previously stated, it had been shown that higher levels of biodiversity lead to a more resilient ecosystem (Goerner et al., 2009). The presence of a multitude of species helps to prevent collapse in the case of extinction. Many conservation policies focus on increased connectivity between various habitats or ecosystems (Hodgson et al., 2009). These approaches are not ineffective at certain aspects of conservation, but they do not foster resilience in the ecosystems they are designed to protect. Conservation of biodiversity, through multiple species conservation or ecosystem-based management, will need to become more prevalent in policies if it is to maintain success in the face of climate change.

Stakeholder engagement

Stakeholder engagement is already present in many forms of public policy. There is no direct link between stakeholder engagement and ecosystem resilience. However there is a link between success of scientific projects and stakeholder engagement (Jolibert & Wesselink, 2012). Conservation actions are usually undertaken by various scientific agencies, and so increased stakeholder engagement is important to the success of any resilience-enhancing conservation undertaking. Recruitment of stakeholders is mutually beneficial for both the stakeholder and the researcher. This is only the case if the stakeholder's role is clear in their contribution to the project (Jolibert & Wesselink, 2012). Costs and benefits of the project must be made clear to the stakeholder, increasing transparency (Jolibert & Wesselink, 2012, Pullin & Stewart, 2006). Stakeholders also respond more positively when a project is presented as a neutral venture, and does not favor one group over another (Pullin & Stewart, 2006). This evaluation framework breaks up stakeholder engagement into two sub sections that represent specific action to be taken. Policies and management strategies will provide legal documentation with explicit statements of expectations and commitment to conservation actions on the behalf of various stakeholder groups (Crabbe, 2010). Stakeholders may include scientists, policy-makers, NGO's, public and private

managers, private sector, citizens, students, facilitators and media (Jolibert & Wesselink, 2012). Additionally, increased transparency and open communication can help to foster trust between conservation actors and citizens (Pullin & Stewart, 2006). Incorporating stakeholders in the process of conservation, from the beginning and throughout the process, will help to improve the success rate of various projects.

Acknowledgement of climate change

Explicit acknowledgement of climate change, both on a global and local level, is needed in all conservation policy, regardless of scale or target (Mawdsley et al., 2009). Yet it is not currently well incorporated into our conservation policy (Hannah et al., 2002). Acknowledgement of climate change has been divided into two subsections to more accurately represent the changes that will help to foster resilience. Explicit use of the phrase "climate change" in any legally binding document helps to acknowledge some of the threats poised against conservation (Mawdsley et al., 2009). Climate change is a legitimate threat to endangered species and ecosystems (Mawdsley et al., 2009, Hodgson et al., 2009). Recognition of climate change can lead to adaptive management that will help to bolster resilience in an ecosystem, through methods such as diverse species conservation (Lin, 2011). It is potentially the single largest threat to these species or ecosystems. Without a formal acknowledgement of climate change in our conservation policies, we cannot expect the management action to initiate action against it. If the policy acknowledges climate change as a threat, then plans can be put in place to deal with it. This acknowledgment requires changes on both a global and local scale. This may require conservation on the timescale of decades, or even centuries, to ensure the protection of these endangered species and ecosystems.

Multiple species or species interaction focus

For the most effective conservation policy at enhancing resilience, a focus on multiple species or specifically on species interaction with one another is required (Soule et al., 2005). A subsection of this attribute was devoted to keystone species because of their importance within an ecosystem. They can have a wide scale effect on multiple trophic levels and on both the biological and physical environment and bolster

resilience by preserving biodiversity (Soule et al., 2005). Contrasted to the single species model, this multiple species focus allows for broader coverage of ecosystems for management (Fogarty & Rose, 2014). By focusing on multiple species or species interaction, we can act on a broader scale and affect more species. This in turn will help to foster biodiversity and thereby enhancing resilience (Soule et al., 2005, Goerner et al., 2009).

Ecosystem or environmental health

While many other policies outside the field of conservation concern themselves with the health of the environment, it would be beneficial for conservation to acknowledge and emphasis the role that a healthy ecosystem plays in the resilience of the species within it. Environment and climate influence system productivity and therefore have a direct effect on the targets for management (Fogarty & Rose, 2014). Ecosystem health creates a stable environment for biodiversity to flourish, and enhances resiliency (Walker, 1995). It should also emphasis the effect that the quality of resources available within the ecosystem contributes to the resiliency of species (Fogarty & Rose, 2014).

3.4 Sample Selection

The three chosen policies, Massachusetts Endangered Species Act (MESA), State Wildlife Action Plan (SWAP) and MassWildlife Habitat Management Grant Program (MHMGP) were chosen from a broad range of Massachusetts's legislation. An information-oriented sampling was used to select these three policies to ensure a representation of the diverse roles that conservation can inhabit within a state government. All three of these policies are enacted, enforced and funded by the state government. They all come from the same source, but are designed for various aspects of all the conservation work that goes on in Massachusetts. MESA deals largely with legislative powers and provides legal authority to conservation actions and penalties. SWAP is the guidelines for the state over the next several and sets conservation goals to be met. MHMGP deals exclusively with habitat restoration and management. None

of these policies achieve the same objective, yet they all contribute to the larger role of conservation in the state of Massachusetts.

3.5 Overview of surveyed policies

Table 2: Characteristics of the surveyed conservation policies

Policy	Year introduced (Last update)	Direct target	Actions prevented	Function
Massachusetts Endangered Species Act	1990 (2010)	Endangered plant or animal species	"Take" or any harm against listed endangered species	Legal protection of listed endangered species
State Wildlife Action Plan	2005 (2015)	Endangered species, habitat, general conservation	Loss of endangered species and habitat	General conservation outline for MA
MassWildlife Habitat Management Grant Program	2016	Habitat conservation	Loss of habitat	Financial assistance for habitat restoration or conservation

Massachusetts Endangered Species Act

The Massachusetts Endangered Species Act (MESA) is designed as the primary legal protection for the conservation of endangered species and the ecosystems they inhabit. MESA was originally drafted by the state legislature in 1990 and was designed to protect species by prohibiting the "take" of any species determine by the state agency, the Division of Fisheries & Wildlife (DFW), in need of protection (EEA, 2016). Defined as any attempt to "harass, harm, pursue, hunt, shoot, hound, kill, trap, capture, collect, process, disrupt the nesting, breeding, feeding or migratory activity or attempt to engage in any such conduct, or to assist such conduct, and in reference to plants, means to collect, pick, kill, transplant, cut or process or attempt to engage or to assist in any such conduct" (EEA, 2016). Permits are allowed for the "take" of these protected species for scientific, educational, conservation or management purposes (EEA, 2016). Regulating this "take" is the primary function of MESA. It also provides legal authority to

list a species for protection. Listing species for protection is a process only undertaken by the Natural Heritage and Endangered Species Program, a division of the DFW (EEA, 2016). MESA was last updated in 2010 (EEA, 2016). It works in tandem with the nationwide conservation policy, The Endangered Species Act (ESA). In addition to the legal protection of endangered or threatened species, it also provides protection for areas of significant habitat. These areas of significant habitat are assessed and determined by the DFW (EEA, 2016). This includes protection from any project or activity that would result in the take of an endangered or threatened species (EEA, 2016). Priority habitat is an area where the potential that a "take" of any endangered species may occur (EEA, 2016). These are identified and reviewed to determine appropriate action. Priority habitats are used for screening projects or activities that may result in the take of a species and to provide guidance to project proponents through consultation with the DFW (EEA, 2016). This protection is applicable to anyone in Massachusetts, resident or visitor, in order to protect these species from harm. While MESA provides legal protection, it does emphasis the need for habitat improvement or management.

State Wildlife Action Plan

The State Wildlife Action Plan (SWAP) largely dictates the overall goals of conservation management by various conservation actors, whether they are state or federal agencies, NGO's or private conservation organizations. Every state has their own version of a SWAP, that emphasizes what they feel are the most important aspects of conservation to focus on. The Massachusetts SWAP is a result of collaboration between the Division of Fisheries and Wildlife (DFW), the Massachusetts Natural Heritage and Endangered Species Program and the Massachusetts Chapter of the Nature Conservancy (DFW, 2016). The SWAP lays out specific conservation goals or areas of focus that will become the crux of conservation work for the state or other conservation organizations operating with Massachusetts. It is broken into six broad categories. Those categories are conservation planning, land protection, habitat restoration and management, environmental regulation, surveys of species of greatest conservation need (SGCN) and habitats, and public outreach (DFW, 2016). The DFW

present the SWAP for review by a Regional Review Team from the federal institution, the United States Fish & Wildlife Service (DFW, 2016). Upon approval by the various institutions this plan becomes the primary objective of conservation action for Massachusetts. It was most recently updated in 2015 (DFW, 2016). This update came from a 2005 document entitled the *Massachusetts Comprehensive Wildlife Conservation Strategy* (DFW, 2016). The update covers a more inclusive range than the original document, including a greater discussion of climate change impacts on species of greatest conservation need (SGCN). In addition of other climate related threats like increased numbers of exotic species or pathogens like the white-nosed syndrome (DFW, 2016).

Within the document there are 24 different types of habitat defined. These are broken down into three scales: large, medium and small (DFW, 2016). Examples of large-scale habitats are unfragmented landscape mosaics, medium scale habitats include state rivers and small-scale habitats include vernal pools (DFW, 2016). There are 287 animals and 283 plants SGCN listed within the SWAP (DFW, 2016). Each species listed within the SWAP is assigned to at least one of the 24 listed habitats, regardless of scale (DFW, 2016).

Crucial to the SWAP is the funding received from the State Wildlife Grant Program, a federal level policy. In order to receive funding from this program, any SWAP must meet eight requirements (DFW, 2016):

- Information on the distribution and abundance of species in greatest need of conservation
- Descriptions of locations and relative condition of key habitats and community types essential to conservation of species of greatest conservation need
- Description of problems which may adversely affect species of greatest conservation need or their habitats, and priority research and survey efforts,
- Description of conservation actions
- Proposed plans for monitoring
- Description of procedures to review the strategy
- Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes

- Broad public participation is an essential element of developing and implementing these plans

By highlighting this funding, the extent of interaction with various stakeholders and action undertaken by the policy becomes clear. These policies do not operate independently, and instead interact with one another. Approval of SWAP is dependent on federal agencies, just as MESA takes part of its legal jurisdiction from the federal Endangered Species Act. Both policies are part of a larger system dedicated to conservation.

MassWildlife Habitat Management Grant Program (MHMGP)

MHMGP is a state government program designed to provide financial assistance to private and municipal landowners of protected lands (DFW, 2016). It supports active habitat management while fostering partnerships to encourage landscape scale habitat management and expand public recreation on conserved lands (DFW, 2016). It is a new and original program, enacted in 2016 (DFW, 2016). The objectives of this program include the improvement of habitat for game species; management of habitat for SGCN as identified in the SWAP (DFW, 2016). A special emphasis is placed on endangered and threatened species (DFW, 2016). It also seeks to expand public recreational opportunities for hunting, fishing, trapping, and other types of wildlife recreation on conserved lands (DFW, 2016). The entities eligible to receive grant funding include owners of private or municipal conserved lands in the Commonwealth of Massachusetts (DFW, 2016). These include NGO's, private conservation organizations or even ordinary citizens. The grantee match commitment is none (DFW, 2016). Applicants are eligible to receive between $10,000 and $50,000 per grant towards their approved habitat management project (DFW, 2016). The allowable activities include, but are not limited to direct costs for on the ground habitat improvements specifically designed to benefit wildlife will be eligible for reimbursement (DFW, 2016). All project costs must be approved in the agreed upon contract budget to be eligible for reimbursement (DFW, 2016). As it is a new program, there is not yet sufficient data on the results any conservation projects undertaken with the grant funding.

3.6 Data analysis protocol

The final stage of analysis was to apply the evaluative framework to determine the extent to which a particular resilience-enhancing attribute was incorporated in the policy. A qualitative analysis determined the effective ranking of each attribute for each policy. A quantitative analysis is not possible as most of the resilience-enhancing attributes are not quantifiable. A policy was given a rank in a specific attribute depending on it's representation of that policy and whether or not it took action also based on that attribute. For example, if a policy acknowledged climate change, both by using the term in its legal documentation and expressed it as a significant threat to species and ecosystems, it would receive a higher ranking. If another policy fails to acknowledge climate change, it would receive a lower ranking. Attributes are not weighted and are all considered of equal importance to one another.

A policy that exhibits ample evidence of both acknowledgement of the resilience-enhancing attribute and action taken received a ranking of "+ + +". A policy that acknowledges the resilience-enhancing attribute, but fails to take suitable action regarding the attribute received a ranking of "+ +". A policy that acknowledges the resilience-enhancing attribute, but fails to take any action regarding it received a ranking of "+". Finally, a policy that fails to acknowledge the resilience-enhancing attribute received a ranking of "-".

4. Findings

Table 3: Evaluation results of three surveyed policies

Resilience-Enhancing Traits	Massachusetts Endangered Species Act (MESA)	State Wildlife Action Plan (SWAP)	MassWildlife Habitat Management Grant Program (MHMGP)
Emphasis on biodiversity	-	+ + +	-
Stakeholder engagement			
Diversity of actors represented	+ +	+ + +	+ + +
Concrete actions to allow co-implementation of strategies	+	-	+ + +
Acknowledgement of climate change			
Use of phrase “climate change”	-	+ + +	-
Climate change as a threat to conservation	-	+ +	+
Multiple species or species interaction focus	-	+	-
Emphasis on keystone species	-	+	-
Ecosystem and environment health	+	+	+ + +
Total	-	+ + +	+ +

Table 3 displays the results of the policy evaluation exercise. For the total, SWAP received the highest ranking (+ + +) for meeting the resilience-enhancing attributes. MHMGP was ranked second (+ +) of the three policies. MESA received the lowest possible ranking (-).

For biodiversity, MESA received the lowest ranking (-) because nowhere in the entire document does it even mention the concept (EEA, 2016). Inversely, the SWAP highlights biodiversity as a theme that crosses all six of the components of the document (DFW, 2016). Its emphasis is clear, “…highest priority conservation actions on a state-wide basis, which are aimed at conserving the biodiversity of the

Commonwealth as a whole…" (Pg. 375, DFW, 2016). This resulted in the SWAP ranking (+ + +). MHMGP also does not acknowledge biodiversity as a focus for the program, instead choosing to focus on habitat, resulting in the ranking (-).

All three policies received some positive ranking for their acknowledgement of the role of stakeholder engagement in enhancing resilience. MESA utilizes public hearings, which allow citizens to provide feedback or voice concerns regarding any policy change in endangered species related issues (EEA, 2016). These public meetings are open to all, including private organizations or NGO's. However, these stakeholders are not involved the process before these public hearings, resulting in MESA receiving the ranking (+ +). The collaboration amongst multiple organizations, both government and NGO's, and feedback provided through public hearings in the creation of SWAP (DFW, 2016) resulted in the ranking (+ + +) assigned. MHMGP likewise received the highest ranking (+ + +) for stakeholder engagement because it allows any member of the public, including private organizations, to propose a habitat restoration project and potentially receive grant funding to enact that project (DFW, 2016).

Neither MESA nor MHMGP make use of the phrase "climate change" and received rankings (-) in reflection of this (EEA, 2016, DFW, 2016). SWAP received (+ + +) in this attribute because it both uses the phrase "climate change" and acknowledges it as a threat for endangered species. Chapter five of the SWAP is entirely devoted to climate change (DFW, 2016).

None of the three policies truly emphasize the importance of conservation focused on species interaction or multiple species. MESA focuses solely on individual species, and listing them for protection (EEA, 2016). Therefore it received the lowest ranking (-). Particular emphasis on keystone species was emphasized in the SWAP (DFW, 2016). This does not directly correlate to the resilience-enhancing attribute, but keystone species affect multiple trophic levels so the ranking (+) was assigned. The MHMGP emphasizes species of greatest conservation need as the primary candidates for habitat restoration (DFW, 2016). It's ranking (-) stems for a failure to emphasis projects that could affect many species, not just one or a few.

A focus on ecosystem and environment health as a resilience-enhancing attribute was scattered intermittently between the policies. MESA tangentially provides legal protection exclusively for habitats of that are deemed of significant value to SGCN (EEA, 2016). The ranking (+) was given as a result of this legal protection for important habitat areas. SWAP largely focused on species conservation, but did contain tenants for habitat and ecosystem conservation, resulting in the ranking (+) (DFW, 2016). MHMGP focused exclusively on habitat and ecosystem rehabilitation or restoration. It sought to improve game habitats and manage habitats of SGCN and received the highest ranking (+ + +) as a result (DFW, 2016).

5. Discussion

5.1 Trends and Patterns

The evaluative framework revealed inconsistencies in the conservation of the three Massachusetts policies. Biodiversity was not regarded across the three policies as a crucial aspect of building resilience. The exception was the State Wildlife Action Plan (SWAP). SWAP did not contain an individual chapter on the importance of biodiversity, instead choosing to acknowledge and incorporate the concept into the varying six categories it covers (DFW, 2016). Conservation of biodiversity is the simplest and most direct connection to enhancing resilience in an ecosystem (Goerner et al., 2009). Similarly the three policies fail to emphasize conservation based on multiple species or species interaction. Once again, SWAP better exemplifies this attribute over the other two; even it fails to truly emphasis a holistically framed ecosystem from this perspective. It's relatively higher-ranking represents special attention paid to keystone species, the conservation of which affects many species throughout the ecosystem. This insistence on a single species type of conservation will ultimately be harmful to conservation efforts as the effects of global climate change become more severe because of the relation between a high biodiversity and increased resilience (Goerner et al., 2009).

There appears to a trend that depends on the age of the policy. Newer policies appear to incorporate more of the resilience-enhancing attributes present within the evaluative framework. Obviously a sample size of three limits speculation, but it is still worthy of observation. The original SWAP, written in 2005, utterly failed to address the topic of climate change (DFW, 2016). In contrast, the updated 2015 version that was analyzed had an entire chapter devoted to the topic (DFW, 2016). MHMGP was enacted in 2016, while it did not receive a superior rating to SWAP, it did incorporate many of the five resilience-enhancing attributes. The Massachusetts Endangered Species Act (MESA) is the oldest of the three policies, last updated in 2010 (EEA, 2016). It also received the lowest ranking of the three policies analyzed. As the primary legal protection policy for endangered species in Massachusetts, MESA should be on the cutting edge of conservation science to be the most effective. This trend supports arguments raised in the literature review. Resilience and conservation are widely used

in the academic literature, but that have failed to properly integrate into policy (Fogarty & Rose, 2014; Hannah et al., 2002; Hogdson et al., 2009).

The idea that climate change is not mentioned in a particular conservation policy is worrisome. The phrase climate change is a politically charged word and its inclusion within a particular forum, especially public policy, is difficult. Any type of conservation that fails to acknowledge climate change does a discredit to the endangered species and ecosystems it claims to protect. The threat of climate in terms of conservation is widely acknowledged in the academic literature (Noss, 2001; Pullin et al., 2009; Walker et al., 2006; Soule et al., 2005). MESA fails to acknowledge climate change as a viable reason for listing a species as endangered and thereby granting protection to that species (EEA, 2016). MHMGP likewise fails to mention climate change. Its scope is narrower than MESA, strictly on habitat restoration or management financial assistance. MESA concerns itself with all endangered species and must be integrated with all other conservation policies of the state.

5.2 Recommendations for enhancing resilience in conservation policy

Increase and unify protection of conservation habitat

Perhaps the most obvious solution is to further increase the amount of protected land. This increase would especially focus on areas with minimal climate impact, movement corridors or unique habitats for wildlife dispersal (Mawdsley et al., 2009). These protected lands would need to be unified under a single governing body, preferably on the state level. This would include all land that is held by the state and federal government as well as NGO's or other private conservation organizations. This idea has been utilized in the academic literature for nations such as Jamaica to designate a single nation park that would contain the entirety of the coral reef ecosystems surrounding the island nation (Crabbe, 2010). Unification of land geographically could represent multiple forest types across different environmental gradients, allowing for easy flow of organisms between the varying forest types (Noss, 2001). This unification of conservation lands in Massachusetts would help to prevent habitat fragmentation, and ensure that habitat renewal projects are working in tandem

with one another. A less fragmented and better-managed ecosystem would help foster biodiversity and bolster resilience of the ecosystem.

Increase stakeholder engagement

There is no direct link between increased stakeholder engagement and enhancing ecosystem resilience, but the successful outcome of scientific projects has been observed to increase due to stakeholder engagement and participation (Jolibert & Wesselink, 2012). Simple public meetings for citizens are not a sophisticated enough method to allow the stakeholders to feel invested in the project. Stakeholders of all varieties need to be included in the process of conservation. These may include scientists, policy-makers, NGO's, public and private managers, private sector, citizens, students, facilitators and media (Jolibert & Wesselink, 2012). Each of these groups needs to provide legal documentation, which explicitly states their expectations and commitment to the project (Crabbe, 2010). This would provide a legal basis on which these various groups would have a voice to be heard in the overall process. This clear and precise contribution to a project has been seen to be mutually beneficial for both the stakeholders and the project (Jolibert & Wesselink, 2012). Additionally, the formation of committees made up various stakeholder groups would be beneficial. These committees would oversee areas of significant habitat for conservation use and allow for the various stakeholders to feel invested in the project (Crabbe, 2010, Jolibert & Wesselink, 2012). Stakeholder engagement is important in all form of public policy, but especially so with ecological-based projects, because there is so often a conflict of interest amongst various groups (Pullin & Stewart, 2006). By making stakeholders feel invested in a project, and that they have some voice, it can help to ensure the success of conservation action.

Inform policy through science

Environmental policy benefits when it utilizes scientific principles. Conservation policy in particular needs to be crafted based upon environmental indicators (Pullin et al., 2009). These may be key indicators of environmental change (sea level rise, habitat fragmentation, etc.), quantitative measurements of intervention effectiveness (number of

individuals) and indirect impacts of non-conservation policy on biodiversity (Pullin et al., 2009). In Massachusetts we need better communication between conservation scientists and policy makers. This is evident in the stark differences between MESA and SWAP. The SWAP expresses conservation goals for the next several years, and highlights many resilience-enhancing attributes. Various conservation actors, including various NGO's and the DFW, put it forth. These are not politicians by training and that reflects in the emphasis that the document places on resilience within its conservation goals. MESA is a more formal and legally binding document. It originates from a much different place within the state government and that likewise reflects in the document.

Acknowledge climate change

Climate change is a significant threat to endangered species and ecosystems around the world and here in Massachusetts (Mawdsley et al., 2009). In all types of conservation policy, regardless of the scale, intention or origin, we need a formal acknowledgement that climate change exists and is a threat to these species and ecosystems. This is particularly so for MESA, which provides a list of six criteria with which a species can be listed for protection (EEA, 2016). These criteria are taxonomic status, reproductive and population trends, native or introduced species, vulnerability, specialization, distribution and rarity (EEA, 2016). Threat of climate change should be added to that list of criteria to ensure that we are properly considering all the species that may be in need of conservation aid. Additionally, the petition process by which species are submitted and reviewed for protection takes too long; up to several years in most cases. This process needs to be expedited if we are to maintain an accurate and up-to-date list of those species that are in danger of extinction. Massachusetts recognizes some of the negative effects that climate change represents, including increased temperatures, sea level rise, changes in precipitation and the number of extreme weather days (EEA, 2011). Part of the government cannot acknowledge and address climate change, while other aspects ignore it. We need to see a unified front to successfully work on conservation of native species and ecosystems.

Shift focus from single species conservation to multiple species

Our current methods of conservation still tend to focus on a single species. We need to see a shift to a method of conservation that focuses more multiple species, species interaction with one another or the system as a whole (Soule et al., 2005, Mawdsley et al., 2009, Walker, 1995, Fogarty & Rose, 2014). By focusing on multiple species, we can increase the scope of conservation projects, as does MassWildlife Habitat Management Grant Program (MHMGP). The current emphasis on conservation projects is designed for the benefit of one species. Instead, conservation should choose to improve the habitat or ecosystem as a whole, which will have benefits far beyond the effort of trying to save one single species. Ecosystem or multiple species models allow for broader coverage of various ecosystems (Fogarty & Rose, 2014).

If we cannot shift from our view of single species conservation, then a step in the right direction would be to place a greater emphasis on the conservation of keystone species. Keystone species affect multiple trophic levels and both the biological and physical ecosystem they inhabit (Soule et al., 2005).

6. Conclusion

This paper sought to develop an evaluative framework that could analysis conservation policy from the perspective of its resilience-enhancing capacity. The framework was constructed after an intensive literature review on the subject of resilience and its relation to the field of conservation. After determining that no such framework previously existed for this subject, five resilience-enhancing attributes were identified, again based off the information gained from the literature review: emphasis on biodiversity, stakeholder engagement, acknowledgement of climate change, multiple species or species interaction focus and ecosystem or environment health.

The evaluation revealed a few important trends in the three Massachusetts policies examined. Biodiversity was not widely regarded across the three policies as a crucial aspect of building resilience. SWAP was the exception, which did acknowledge biodiversity as important but failed to lay out concrete strategies to address the conservation of it. Conservation of biodiversity is viewed as the simplest and most direct connection for enhancing resilience (Goerner et al., 2009). There appeared to be a trend that depended on the age of the policy with newer policies appearing to incorporate more of the resilience-enhancing attributes than older ones. Acknowledgement of climate change varied widely across policies. From the perspective of the evaluation framework it would also be desirable to see climate change widely acknowledged as one of the most dangerous threats to species and ecosystems to reflect arguments in the academic literature (Noss, 2001, Pullin et al., 2009, Walker et al., 2006, Soule et al., 2005).

The evaluation allowed us to provide a few recommendations that could improve these three Massachusetts conservation policies. These include an increase in the amount of protected land, especially areas with minimal climate impact, wildlife corridors and stepping-stone habitats (Mawdsley et al., 2009). Protected lands would then be unified under a single governing body (Crabbe, 2010). From the perspective of the evaluative framework, it would also be desirable to see an increased level of stakeholder engagement, with various groups providing legal documentation stating expectations and commitment to various conservation projects and including them on committees which would manage these projects (Crabbe, 2010). Any reform or new

policy introduced should be based on scientific principles, utilizing environmental indicators like quantitative measurements of intervention effectiveness and indirect impacts of non-conservation policy on biodiversity (Pullin et al, 2009). Crucial to any type of conservation policy is the formal acknowledgement of climate change as significant threat to endangered species and ecosystems (Mawdsley et al., 2009). It also needs to be recognized as a threat to species and ecosystems in policies like MESA, by adding it to the list of six criteria with which a species can be listed for protection (DFW, 2016). Finally, we proposed a shift from single species conservation methods to one that focuses on multiple species, interactions or ecosystems (Soule et al., 2005, Mawdsley et al., 2009, Walker, 1995). If that shift is to extreme then a greater emphasis on keystone species would also be beneficial (Soule et al., 2005).

This evaluative framework was designed specifically for use in exploring the relationship between resilience and conservation policy. The framework has been constructed to be general enough that it can analyze any type of conservation policy, regardless of scale, intention or origin. Three Massachusetts policies were selected to demonstrate the effectiveness and potential usefulness of this evaluative framework as a tool. It was important that nonscientists be able to utilize the framework and understand the results from analyzing conservation policy. This allows for a multitude of audiences members, including policy-makers at the state or federal level, NGO's, private conservation organizations or even citizens to make use of the framework. This evaluation could be used to identify problems with a conservation policy and then serve a guiding framework for improvement measures to be employed. After all, conservation seeks to protect these various species and ecosystems against threats to their existence. It is hoped that this evaluative framework can be used a tool to aid with that process and that it proves useful in the field of conservation.

Conservation that focuses on enhancing resilience is more important than ever. Climate change is a result of humanity's role in the sixth mass extinction event and we have increased the extinction rate far above any natural level (Barnosky et al., 2011, Rockström et al., 2009). We need to start seeing a shift to a greater emphasis on resilience. The effects of climate change are already being felt (IPCC, 2014). They are only become more severe as time passes (IPCC, 2014). As a society, if we care at all

about the other species that inhabit our planet, we need to start to prepare to deal with these negative effects caused by our thoughtless actions. There is no one solution to dealing with conservation, but resilience can help to negate some of these negative effects of climate change. It can give endangered species around the globe a chance to deal with climate change. It is vital to integrate the concept of resilience into our conservation policies and we need to start that process now.

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