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Abstract. Recent work has suggested that conservation efforts such as restoration ecology and invasive species eradication are largely value-driven pursuits. Concurrently, changes to global climate are forcing ecologists to consider if and how collections of species will migrate, and whether or not we should be assisting such movements. Herein, we propose a philosophical framework which addresses these issues by utilizing ecological and evolutionary interrelationships to delineate individual ecological communities. Specifically, our Evolutionary Community Concept (ECC) recognizes unique collections of species that interact and have co-evolved in a given geographic area. We argue this concept has implications for a number of contemporary global conservation issues. Specifically, our framework allows us to establish a biological and science-driven context for making decisions regarding the restoration of systems and the removal of exotic species. The ECC also has implications for how we view shifts in species assemblages due to climate change and it advances our understanding of various ecological concepts, such as resilience.

Keywords: climate change, community, invasive species, resilience, reference condition, restoration

Introduction

Ecological restoration focuses either on the repair of “damage caused by humans to the diversity and dynamics of indigenous ecosystems” (Jackson et al. 1995) or on the recovery of those ecosystems (SER 2004). However, recent work has questioned the relative roles of scientific, ethical and aesthetic principles in establishing the value of such ecosystems and the consequential prioritization of management actions (Higgs 1997). For example, Davis and Slobodkin (2004) argue that communities have no "…intrinsic evolutionary or ecological purpose…" and therefore it is not valid to, "…invoke any ecological (or evolutionary) rationale to establish particular restoration goals." The argument has also been made that attempting to restore communities is a value-driven pursuit based more on human judgments than on ecological structure and processes (Choi 2007). Others recognized the role of value-driven goals in restoration while suggesting that ecological restoration has a foundation with empirical support (Winterhalder et al. 2004).

While philosophers debate whether restoration of ecological communities is justified, the practice is occurring on large scales; we suggest this disparity is encouraged by a lack of prior clarity about what the relevant entities are, what criteria are used to delineate them, and why. Although the concept of a community is frequently invoked as the relevant target of restoration, there has been little examination into how to differentiate among communities or identify them as ecological entities. Given the relevance of a community concept to current ecological and conservation-oriented problems the need for introspection is clear (Simberloff 2004).

The effective restoration of communities is hindered by a lack of consistency regarding what a community is; numerous definitions have been developed (McCoy and Shrader-Frechette 1992, Mikkelson 1997). For example, definitions include those that stress dominant species (e.g., Ricklefs 1990), interactions (e.g., Wilbur 1972, Holt 1977), or statistical properties (Field et al. 1982; Clarke 1993; Leaper et al. 2014). Some researchers have presented more refined definitions (e.g., Looijen and Andel 1999) to enhance precision for addressing ecological questions while others have argued that a very general definition for what constitutes a community will suffice for most studies (Fauth et al. 1996, McGill 2010). The existence of multiple definitions of a community can probably be attributed to the complexity of these systems, which tends to preclude development of general laws (Lawton 1999). In any case, given a relative inability to define a community it should not be particularly surprising that some have suggested they are of little importance (Ricklefs 2008).

Restoration efforts often presuppose an implicit concept of the target of restoration, typically a community or species assemblage within a given area. However, one consequence of the ambiguity surrounding restoration targets and a lack of consistency regarding community definitions is that we risk managing damaged ecosystems so that they move toward conditions that represent a reconstructed system with missing or novel parts. At the same time, rapidly changing climates and landscapes limit our ability to achieve restoration targets based largely on historical conditions (e.g., Jachowski et al. 2015); however we suggest below that the evolutionary interactions existing within communities contain information that can help guide the formation of restoration targets. We provide an explicit characterization and justification of this concept, which we will call the Evolutionary Community Concept (ECC).

What is an Evolutionary Community?

We propose that an Evolutionary Community is conceptualized as a unique assemblage of species, which occurs in a given geographic area and is connected by interspecific and abiotic interactions that have evolved over time. As the name suggests, our concept foregrounds evolutionary considerations. In generating this concept we favor ultimate over proximate approaches to community ecology (Losos 1996). Proximate approaches concern themselves with, "the processes occurring within communities and the effect those processes have on community structure" (Losos 1996). However, the species present in a given area are not solely influenced by current forces and may be a function of the evolution of a particular lineage in a given area (Helmus et al. 2007, Cavender-Bares et al. 2009). Ultimate approaches to community ecology, which acknowledge that evolutionary lineages are likely to be spatially constrained, come closer to helping us conceptualize communities as something more than just a collection of arbitrary species. Such an approach is defined by Losos as, "involv[ing] study of why communities have particular organization and why differences exist between communities [emphasis ours]" (Losos 1996).

Evolutionary Communities are Natural Entities

Natural entities are widely recognized as those objects or systems that exist as entities without regard to human actions or beliefs (Eldredge 1985, Lo 1999, Castree 2004, Katz 2009). An extensive literature has developed around the argument that biological species are a particular type of natural entity – an individual (Hennig 1966, Ghiselin 1987, Hull 1976, Wiley 1980, Holsinger 1984, Mishler and Brandon 1987, Ereshefsky 1992, Baum 1998, Coleman and Wiley 2001, Mayden 2002, Rieppel 2007, Reydon 2009). A similarly useful framework was provided more recently regarding areas of endemism (Crother and Murray 2011). Communities differ from areas of endemism because they cannot be identified from a single species and they are not hierarchical (i.e., larger communities do not necessarily contain smaller ones). Further, communities are not characterized by endemic species on any scale and do not require them to be identified as a unique individual. Finally, the structure and composition of communities are influenced by interspecific, as well as abiotic, interactions (Fontaine et al. 2011) that have coevolved over time, which may or may not be true for areas of endemism. We do not make the claim that ecological communities are individuals in a metaphysical sense; however, we believe the established framework is useful for developing an understanding of ecological communities as natural entities.

A framework for identifying communities as natural entities

Boundaries

Eldredge (1985 p. 162) states that, "some ecologists…take strong issue with the suggestion that communities can be construed as individuals. The problem seems to come from the apparent lack of definitive boundedness to such entities." Evolutionary Communities, like species, have fuzzy boundaries in space and time. Nevertheless, Evolutionary Communities, we argue, are like species in being natural ecological entities that exist independent of anthropogenic naming conventions. Their spatial and temporal boundaries are determined by natural evolutionary processes, rather than by us and it is the gradualness of evolution that explains the fuzziness of those boundaries (Clarke & Okasha 2013). Previous concepts suggesting that communities are natural entities (e.g., Clements 1916) may have been evaluated unfairly by imposing an expectation that temporal and spatial boundaries between communities should necessarily be sharp. Although it is possible to delineate a discrete boundary surrounding an assemblage by stipulating a threshold for a particular variable (such as the density of a given species or interaction) (e.g., Highton 1989), such thresholds will always be arbitrary (Frost and Hillis 1990). Even organismal boundaries admit fuzziness when we consider, for example, strands of hair. Allowing a certain degree of fuzziness when delineating boundaries is not a concession to our limitations at identifying their extent but rather a more accurate characterization of the entity in question (Baum 1998).

Evolutionary Communities, like organisms and like species, can be fuzzily bounded. However, we can determine approximate spatial bounds according to biogeographical patterns in species richness and composition. For example, an area's biological uniqueness may be inferred after using null models to demonstrate that observed patterns differ from random expectations (e.g., the mid-domain effect; Wollenberg et al. 2008, Kozak and Wiens 2010). It is necessary to have some a priori designation of the spatial boundaries of areas so that patterns of species richness may be compared for these analyses; operationally, areas may be defined by a grid system (e.g., Hawkins and Diniz-Filho 2002), political boundaries (e.g., Means and Simberloff 1987), or elevation (e.g., McCain 2004). Species composition may allow us to distinguish between areas with similar species richness patterns. If a group of species occurs in sympatry more frequently than expected (e.g., as defined by null models; Gotelli 2000), this suggests the area is subject to ecological or evolutionary forces resulting in a particular species assemblage. If these same species occur together more frequently in a given geographical area than they do in other geographic areas, these areas may be considered discrete. In addition to co-occurrence analyses, parsimony analysis of endemicity (Morrone 1994) is a method of identifying areas with unique species compositions and analyses may be performed to determine areas of endemism that cluster significantly frequently (Huang et al. 2008), a feature that may aid in development of hypotheses for the historical origin of communities.

Like species, Evolutionary Communities will also have fuzzy temporal bounds. Over time, extirpation and colonization may shift species composition patterns such that they cease to be different from nearby geographic areas. Species that were part of a community may alter or cease interactions with other species in a way that is outside the bounds of the distribution by which they were previously characterized. Conversely, at some point in time, random species assemblages in a given area can become non-random and different from other areas. Species within such areas would likely begin interacting and shaping the evolutionary trajectories of one another. So, although it is operationally difficult to pinpoint precise beginnings or ends, it is theoretically plausible that one could assign temporal boundaries to a unique group of species within a spatial area (Figure 1A). Species concepts such as the Phylogenetic Species Concept (Cracraft 1983, 1987) may provide an analogous solution toward resolving the temporal beginning and end of a community.

The temporal bounds of an Evolutionary Community will be determined by several causes, including anthropogenic climate change or succession (Gleason 1926; Figure 1B, C) and biogeography (Wiley 1988). Individual phylogenies of species are influenced by vicariance and dispersal events, and these individual phylogenies may ultimately influence community assembly (Webb et al. 2002; Figure 1D). It is also the case that such biogeographic events may act directly on the incipient community, rather than being propagated through species. For example, the creation of a river, or separation of tectonic plates could split a community, a divergence of ecological significance resulting in a rather sharp boundary. Similarly, the removal of geographic barriers will allow two communities to converge.

It follows from the ECC that a given area will possess multiple communities over geological and ecological time as changing climates, autogenic, and allogenic processes alter habitat suitability for a given suite of species. Because species and interactions will be replaced over time, succession will also result in multiple communities. Nevertheless, the scale of relevance to most ecological studies suggests communities can change to some degree through time yet retain their identity. Individual organisms may undergo relatively drastic changes over the course of their lives – such as in the case of a tadpole developing into a frog or a caterpillar into a butterfly – while retaining their identity (Hull 1976). Similarly, Evolutionary Communities will change, for example as when populations of competitors, or of predator and prey, fluctuate in abundance. Fluctuations in the frequency, duration, or intensity of natural disturbance may also occur. If organisms and species can change, within certain limits, and stay the same individual, then Evolutionary Communities can too. So long as the unique coevolved assemblage of species and their associated interactions are extant and functional, an Evolutionary Community remains the same individual.

An Ostensive Definition

Evolutionary Communities, like species, lack essential intrinsic properties. For example, no list of intrinsic properties can be considered as necessary and sufficient for qualifying as a tiger, because tigers evolve continuously and without limit (Hull 1994). There is no characteristic whose appearance would make a tiger’s cub into a member of a new species (Sober 1994). New species come into being gradually, over lengthy timescales, as a consequence of speciation events which break down the cohesive forces which hold the members of a species together. Likewise, Evolutionary Communities may not be defined by any list of member species or other structural or functional characteristics. They are bounded only by discontinuities in the form or pattern of interactions amongst their parts – though it may be up to us to set thresholds for these discontinuities.

As noted above, certain species will co-occur together within a given area more often than expected by chance and more often than they co-occur together elsewhere. These species are often considered specialists of a given habitat with limited geographic distributions. Indicator species analysis (Dufrêne and Legendre 1997) may be a useful means of identifying characteristic species of a given area. Such species help diagnose communities based on their presence in a manner to analogous to genes providing guidance for the diagnosis of species. For example, at the scale of a forest stand, the presence of longleaf pine (Pinus palustris), gopher tortoises (Gopherus polyphemus), red-cockaded woodpeckers (Picoides borealis), and wiregrass (Aristida sp.) in a given area is sufficient to identify that the assemblage is unique to the Coastal Plain of the Southeastern United States. In sum, we can define communities ostensively by observing characteristic species in a certain place at a certain point of time and documenting a history of interactions that shaped the evolution of these species. The presence or absence of any one of these species is not sufficient to consider the community extinct, just as the presence or absence of a single gene would not cause of us to re-evaluate the status of most species. Nevertheless, at some point of loss or gain of species and their interactions community identity would change.

We must revisit the issue of scale. If our area of interest was planet Earth and we wished to compare the species assemblage of Earth to neighboring planets, then every species is an indicator of Earth. As the focal scale decreases, widespread species will begin to stop playing a role in what makes a given area unique. For example, the gopher tortoise is an indicator of Earth, the continent of North America, the Coastal Plain of southeastern United States, and the longleaf pine forest, but not the pitcher plant bogs that may occur within longleaf pine forests. Beyond the scale of the longleaf pine forest, the gopher tortoise is not useful for differentiating between areas.

This matter of scale may shed some light on controversial subjects in ecology. Neutral theory (Hubbell 2001) suggests communities may be comprised of assemblages of organisms arising from forces independent of species interactions. Similarly, Gleason (1927) argued that the structure of a particular assemblage is due largely to pioneering species; these species become established due to their dispersal abilities, rather than because they belong to any discrete entity. These ideas, at least on small temporal and spatial scales, appear to run counter to some of community ecology’s most basic underpinnings (Chase and Leibold 2003). We suggest that examining an assemblage at an inappropriate scale may encourage misleading interpretation. Continuing our longleaf pine forest example, quantifying species composition within forest stands of a few hectares each may reveal that the species within each stand appear random. However, at a larger scale, the species characteristic of longleaf pine forests are different than those that appear in a ponderosa pine (Pinus ponderosa) forest, or in the Sonoran desert. At this scale, species assemblages are not random, they are distinct.

Community Cohesion

The parts that make up Evolutionary Communities are heterogeneous, rather than conforming to a common type, but are bound into a single entity by virtue of historical causal connections. Organisms are bound into a common species thanks to reproductive and ecological interactions. What processes cause an assemblage of species cohere into a community? We argue that the parts of Evolutionary Communities are bound together by interspecific interactions in a shared biotic and abiotic environment, which promote co-evolution and community structure and dynamics (Johnson and Stinchcombe 2007). For example, longleaf pine trees are conduits for lightning strikes that ignite a highly flammable understory, often including dropped longleaf pine needles (Platt et al. 1988). The resulting ground fires are necessary for reproduction of other species (e.g., wiregrass; Mulligan and Kirkman 2002) and maintain habitat suitable for others (e.g., gopher tortoises, Yager et al. 2007). Gopher tortoises, through the process of burrow creation, provide structure important to other species (e.g., Jackson and Milstrey 1989, Kinlaw and Grasmueck, 2012). The establishment of one or more of the species listed above facilitated the persistence of additional species. In addition, a change, such as gradual climate change that alters the abiotic conditions in a given area, will likely reduce habitat suitability for one or more species. Due to the influence of interspecific interactions, many species within the unique assemblage are likely to respond cohesively.

If we recognize an Evolutionary Community as a natural entity, for example, the longleaf pine forest community, there cannot be another longleaf pine forest community.

This does not preclude the possibility that the long leaf pine community has many parts that are separated in time and space, as long as we assume that these parts are linked via current ecological interactions (e.g., via dispersal events), or through their historical evolutionary interactions. As an analogy, populations of the same species frequently occur in different and isolated areas. Similarly, there can be many members of an ecological community that are naturally isolated, such as pitcher plant bogs or Carolina bays, or were once continuous but have now been fragmented by anthropogenic influences, such as the longleaf pine forest.

Applications of the Evolutionary Community Concept

Exotic Species

Perhaps the most relevant application of the ECC concerns exotic species (i.e., a species living outside its native range, Hunter 1996) and particularly those exotic species that become invasive (e.g., Fritts and Rodda 1998). Invasive species management is often driven by a desire to rid a particular area of species deemed damaging to the native species or communities (e.g., brown tree snakes, Boiga irregularis, in Guam) but this type of management has been criticized as potentially xenophobic or based primarily on ethics (e.g., Brown and Sax 2005). This criticism is likely encouraged by the fact that identification of communities has heretofore been subjective (Simberloff et al. 2003) and did not sufficiently differentiate between species considered native versus those that are considered introduced (e.g., Fauth et al. 1996). However, if communities are spatially and temporally bounded and consist of a unique assemblage of species and their associated interactions, then exotic species threaten their continuity. Removal of invasive species can be justified not because they are ugly or non-traditional, but only because their interactions with the other members of the community are not part of the evolutionary history of that community. This fact alone may not be viewed by many as sufficient to justify removal of exotic species. Finding such a justification is not our purpose; instead, we aim to expand the theoretical context around which such debates take place.

Because humans influence the planet on a scale larger than any other single species (Vitousek et al. 1997), it is reasonable to categorize human activity as distinct from other biotic processes. Species physically moved by humans or whose movements were facilitated through infrastructure, such as imported decorative plants, invertebrates within ballast water, or escaped pets, are not components of the native communities they were introduced into. The proximate cause of invasion by many species is clearly direct human intervention and their presence in an area is not due to the community's unique evolutionary lineage. Because exotic species may result in the functional extirpation of a native species, as well as the functional extinction of interactions between native species (e.g., Ricciardi and Simberloff 2009), they may result in the demise of the original community. Consequently, under the ECC, efforts to eradicate exotic species are consistent with a desire to maintain a community's identity while assisted migration efforts (McLachlan et al. 2007) are not if they result in a species interacting with other species different from those it evolved alongside.

Some have argued that the presence of exotic species in a given area may have conservation benefits (Schlapefer et al. 2011), by providing ecosystem services or when exotic species fill the role of extinct organisms. For example, coyotes heave colonized the eastern coast of the United States and largely fill the niche of extirpated wolf populations (Tingley et al. 2009).In this case, although co-evolution was not a factor in an exotic species' role within a community, its role is indistinguishable from those that arise from co-evolutionary processes. If we regard the interspecific interactions a species partakes in as the defining component of its identity, we may recognize these exotic species as components of communities. However, if we regard identity as a function of unique evolutionary trajectories and spatio-temporal boundaries, as outlined in this essay, then exotic species can never be components of communities. This dichotomy has important implications for the debate regarding whether restoration of ecological processes may be more important than the species used to restore them (e.g., Pleistocene re-wilding of North America; Donlan 2005).

Climate Change

We lay out an argument here that a subset of species within an area comprise a unique assemblage, are strongly interacting, and are consistently present within a given community type and not elsewhere. It is these species that help us differentiate among communities. The ECC has immediate implications for how to view changing global dynamics. For example, climate change is expected to elicit species-specific responses (Davis and Shaw 2001) and range shifts among individual species (Parmesan and Yohe 2003), which may in turn lead to community disassembly (Thuiller 2004) and eventually the formation of new communities. If one views communities simply as the groups of species residing within a given area, the effects of climate change may be mitigated by complex landscapes, which will likely continue to harbor a diversity of species (Anderson and Ferree 2010). However, if we recognize the importance and unique nature of interspecific interactions, we may be less optimistic regarding how communities will fare in response to anthropogenic-driven climate change, as interacting species may have varying abilities to adapt and persist (e.g., Parmesan 2006). The way we conceptualize communities should not change the adaptation strategies we consider in the context of changing climates (e.g., Stein et al. 2013); however, the ECC offers a baseline against which future management options can be assessed.

Reference Conditions

Many restoration efforts are gauged by comparison to reference communities and environmental trajectories. However, current definitions for communities characterized by dominant species, interactions, or statistical properties are often inconsistent with the goals of restoration ecology. In the United States, for example, restoration ecology is often primarily concerned with returning degraded communities into a condition consistent with the species composition and abundance that may be expected prior to modern agricultural and industrial modification of the landscape, or alternatively, what we would expect to see today in a given area if that past modification had never occurred. It is thought that these target conditions, which will always include some degree of natural variation (White and Walker 1997), likely best represent the ancestral condition. The ECC, which posits that these target communities are natural entities due to their unique species assemblages, evolutionary histories, and interspecific interactions, offers a scientific rationale for this approach.

Ethical and aesthetical considerations will remain important in choosing one set of reference conditions over another – for example in determining the point in time used to assess reference communities. However, such deliberations will act as supplements to, rather than replacements for, objective considerations involving the suitability of current climactic conditions and the co-evolved dependencies between different parts of a community. We do not include a particular species as a component of a target condition because it is beautiful or for historical accuracy, but because the rest of the community depends upon it.

Disruption of natural disturbance regimes within a given community may encourage the proliferation of a species previously present at low levels. Although these species are not exotic, they may disrupt the continuity of a community. For example, fire-suppression of longleaf pine forests allows oak trees to increase in abundance, resulting in a change in the habitat structure and a reduction in habitat quality for other species (Mitchell et al. 2006). This change may eventually result in a transition to a different community. Therefore, efforts to restore natural disturbance regimes and manage species to levels that best typify a community are warranted, if the goal is to maintain a community that exists due to natural processes.

Although a common focus of restoration ecology is restoring lost communities (SER 2004), it is implied by the individuality of Evolutionary Communities that once lost, communities can never be recreated (Katz 2009). Once an organism dies, it is impossible for a new organism to be numerically identical with the lost creature, no matter how similar they may be. This is because the causal-historical connections which bind the parts of an individual together have been severed. Similarly, we once assumed that an extinct species could not be resurrected. Recent technological advancements challenge the idea that extinction is forever (Sherkow and Greely 2013). Similar to species resurrection, we argue that it is possible to conceptualize how Evolutionary Communities can be reborn. For example, constituent species of a community could endure throughout the period in which the Community is missing (such as when habitat quality degrades). If those species are not subject to sufficient evolution such that their response to and interaction with the other members of the Community cannot be re-established, then community rebirth is plausible. In other words, we can consider the relevant ecological interactions to be merely paused, while the Community is disassembled, rather than entirely severed. In these cases, restoration of the abiotic environment and the appropriate assemblage of species can result in the ecological interactions resuming as before (Gibbs et al. 2007).

Restoration ecologists often strive to replicate the species composition and abundance derived from a unique evolutionary history and use dominant species, interactions, or statistical properties as secondary metrics to evaluate success. For example, much has been discussed regarding the relative merits of focusing on one species for conservation efforts versus a suite of species (e.g., Lambeck 1997, 2002, Lindenmayer et al. 2002) or even entire communities (Simberloff 2004). However, the ultimate goal is always the same, i.e., to restore, or at least conserve in some form, the group of species in a given area that best represents what was found in the area due to evolutionary processes.

Community Resilience

Resilience refers to the time required for a system to return to its equilibrium following disturbance (Pimm 1984). Our conceptualization allows a community to experience some change, therefore we can incorporate ecological resilience. For example, if we define a longleaf pine community as any forest dominated by P. palustris, exhibiting a set of characteristic co-evolved traits, and subject to frequent (<3 yrs) fire, then the forest is no longer a longleaf pine community once some threshold of time has passed without a fire. Although a forest that has been fire-suppressed for a few years will likely appear somewhat different than a forest that was burned more frequently, this is due primarily to fluctuations in the densities of species that were always present. Even after a P. palustris-dominated forest is fire-suppressed for decades, restoration of fire alone is sufficient to alter the structural components of the forest (e.g., vegetation, bird and reptile populations) such that they are indistinguishable from forests that have been burned regularly (Outcalt and Brockway 2010; Steen et al. 2013a, b). Over this time period, we argue that it makes most sense to conceive of a longleaf pine community as a single entity that experiences some degree of change over time. However, once the unique species assemblage begins to change through extirpation and colonization, the original community has ceased to exist and can never return to an equilibrium.

Conclusion

We have presented a concept which treats communities as entities that have formed over evolutionary time; this concept allows for a philosophical platform to help us understand what many conservation and restoration efforts are trying to accomplish (Table 1). In doing so, we have built upon the work of Losos (1996), who identified a dichotomy in how communities are conceptualized; specifically, our conceptualization complements work emphasizing the importance of historical influences in current community structure (e.g., Losos 1996, Ricklefs 2008, Cavender-Bares et al. 2009). If the components of a community result from historical forces, it is likely most appropriate to consider these forces when defining a community. Restoration ecology goals and ecological questions should be focused on the unique species assemblage of a given area as well as the associated evolution interactions among species and abiotic factors.

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Fig 1 New communities can arise from a variety of different processes. Transitions (represented here as fuzzy bars in the absence of discrete geologic events) may occur simply because communities change constantly over time and/or space (A). In (B) community X transitions to a new state as a result of either a natural transition (e.g., succession) or some anthropogenic disturbance. Transitions may also occur as a result of repairing community degradation (fuzzy gray bar in C). It is possible to manage degraded communities such that the structure and function of the original community is replicated (represented by X_1). I In (D) community W transitions into two communities (X and Y) following biogeographic divergence (e.g., the division of a community following a shifting river channel). If a biogeographic convergence event merged communities X and Y, they would form a new community Z. In all of the above scenarios, the scale of relevance to the researcher may allow for a community to experience some degree of change over time while remaining the same entity.

Table 1. Description of how conceptualizing communities as natural entities changes the way we perceive environmental change and conduct studies of restoration ecology and community ecology. This table is not mean to be comprehensive; our goal is to be explicit regarding how the Evolutionary Community Concept (ECC) offers a different perspective. We acknowledge that previous studies have conceived of communities in manners consistent with one or more of the columns we describe below.

Community Definition:	**Collection of Species**		**ECC**	
Focus	**Species-based**	**Ecosystem-based**	**Species-based**	**Ecosystem-based**
Restoration ecology	Ensure the presence of select species (ecosystem engineers, dominant vegetation types, charismatic species, etc). Goals for restoration may be largely value-driven	Ensure the presence of select species and system functions (ecosystem engineers, dominant vegetation types, and species promoting ecosystem function). Goals for restoration may be largely value-driven or driven by the	Ensure the presence of species selected on the basis of their contribution to community identity (ecosystem engineers, dominant vegetation types, and species with co-evolutionary relationships)	Ensure the presence of species selected on the basis of their contribution to community identity and their associated functions (ecosystem engineers, dominant vegetation types, and species with key co-

		need for specific ecosystem services		evolutionary relationships)
Climate change	Focus on individual species responses, adaptation strategies such as assisted migration, and "preserving the stage" (Anderson and Ferree 2010) likely viable options	Focus on system-level response to climate change; adaptation strategies such as assisted migration likely viable – particularly if they result in maintaining ecosystem function/services	Focus on individual species responses; adaptation strategies focused on building resilience, identifying refugia and limiting external stressors promoted over moving species and generating new communities	Focus on system-level response to climate change; adaptation strategies focused on building resilience, identifying refugia and limiting external stressors promoted over moving species and generating new communities

Invasive species	Gauge impact by determining response of other species. So long as all species remain extant, invasive species has no significant impact	Gauge impact by determining total number of present species and presence of interactions of interest, regardless of species identity	Gauge impact by determining response of other species, as measured by alteration of interactions, and relative abundance	Gauge impact by determining response of other species, as measured by alteration of interactions and relative abundance, and by considering whether community identity has become more homogenous to other communities and/or ecosystem function has declined
Studies of Community Ecology	Study of interactions will use species of interest to the researcher	Studies of interactions at the system level will be conducted regardless of the number of communities encompassed by a given interaction	Study of interspecific interactions will include species that share an evolutionary history with a given area and habitat	Study at the system level will consider community boundaries when designating study areas and appropriate spatial extent of interactions. Focal species will include those that share an evolutionary history with a given area and habitat