# Habitat Defragmentation in the North Country

## Establishing an A2A Corridor Linkage in St. Lawrence County

By Hannah Follender and Kristi Onzik

## I. EXECUTIVE SUMMARY

Human development in rural areas is a process consistently preceded by the construction of roads and followed by the division and distribution of property for home building and commercial use. Property divisions tend to result in the separation and alteration of previously existing natural habitat. These habitats may be a key part of a species' home range or used as a migratory corridor for seasonal migration. The alteration of land, by roadway construction or home development, brings with it the consequences of pollution (noise and waste) and habitat fragmentation. Habitat fragmentation can lead to inbreeding within isolated populations, and can also influence a species' home-range size (Gehring and Swihart 2004). Roads may act as a primary form of habitat fragmentation, but the alteration of landscapes by private property owners increases that fragmentation. This is done by converting natural areas into agricultural areas, as well as by creating manicured green spaces for recreation or aesthetic pleasure.

Land development in rural areas has the potential to be more detrimental to the environment than urban or suburban sprawl. Rural sprawl combines low housing density over large areas which results in lower development intensity than urban or suburban areas; however, rural sprawl may be more biologically significant in that it tends to occur over larger areas and the initial landscape is relatively less-altered so the impact of new construction is greater (Radeloff *et al.* 2005). The fact that rural sprawl takes place over larger tracts of land results in more habitat fragmentation and habitat loss per unit, and the number of roads connecting widely spaced residences increase disproportionately to the number of people utilizing them (Radeloff *et al.* 2005).

To mitigate the effects of rural sprawl and landscape alteration it is important to assess the areas that have been developed, or are in the process of being developed, and apply strategies to remedy the effects of habitat fragmentation. St. Lawrence County in Upstate New York is characterized by its low population density and its agricultural history. Large tracts of land are used for farming, while US Highway11 provides a major trucking route through the area. The development of heavy-use roads and the clearing of land for agricultural use have caused the natural habitats of species to become fragmented as land development has isolated certain species from their habitats in the Adirondack Park. The Algonquin 2 Adirondack Conservation Association has initiated a plan to connect the Algonquin Park in Canada to the Adirondack Park in Central New York State by implementing a wildlife corridor through the use of land easements and local education programs.

The majority of land in core and edge area of the potential Adirondack to Algonquin Corridor is privately owned. Educating landowners about the habitat connectivity program and gaining their support in controlling their land-use practices to facilitate habitat defragmentation and wildlife migration is the issue. With a lack of regional coordination and funding, it is difficult to acquire large tracts of privately owned land for the purpose of maintaining them as conservation easements that would be conducive to the A2A program.

To assess the extent of habitat fragmentation in St. Lawrence County, we used GIS mapping techniques in ArcMap 9.3 to visually assess road density and land-use inside and outside of the Adirondack Park. We also overlaid a map of the Algonquin 2 Adirondack corridor to evaluate road density and land-use in the core and edge corridor areas. Southern St. Lawrence

County falls within the core corridor area, while central to northern St. Lawrence County makes up the edge corridor area.

It was important to learn about conservation organizations currently operating in the area that have taken on habitat defragmentation initiatives. We conducted interviews with Erika Barthelmess, the President of the St. Lawrence Land Trust, and Mark Scarlett of the Indian River Lakes Conservatory. We also used online resources provided by the Thousand Island Land Trust and Tug Hill Tomorrow Land Trust to learn about their conservation easement programs. We also interviewed John Montan of the St. Lawrence County Planning Office to learn about development, zoning, and environmental issues in the area.

In identifying and evaluating possible solutions we assessed cluster development, raw material processing, the development of renewable energy programs, the creation of an ecosystem service market, and conservation easements. After assessing all of these programs we concluded that the best plan for a defragmentation program seems to be one that combines cluster development and conservation easements. By encouraging growth in and around the central business district, there should be less development pressure on lands further from the center of town. This combination of centralized revitalization, and conservation easements for land currently held privately, could contribute tremendously to the goal of conserving large tracts of land to supplement the A2A corridor.

With strategic and early planning, a community can prioritize which land is most important to conserve and which land can accommodate projected future growth. Because development and conservation are inextricably linked, we must plan for “smarter” growth

strategies that provide for economic development and environmental protection which are both compatible and mutually supporting.

## II. PROBLEM DEFINITION

The U.S. population boom of the twentieth century brought with it the phenomenon of suburban sprawl as people moved their families from fast growing cities out to the country-side. As people took up residences outside of cities, some moved beyond suburban areas and created what we know today as the rural expansion. Rural areas are difficult to define and their composition may differ between rural areas in high population states and rural areas in low population states (Cromartie and Bucholtz 2008). Rural communities in the U.S. comprise 17 percent of the population and roughly 75 percent of the total land area (Cromartie and Bucholtz 2008). Historically, rural areas were used primarily for the production and extraction of resources. These activities spurred the growth of towns which provided a venue for the sale of natural and agricultural goods (USDA ERS 2003). Today, we still characterize rural areas by their relative abundance of farms, prairies, forests, and rangelands that surround small town centers. The International City Management Association created five classifications for rural communities: gateway communities, resource-dependent communities, edge communities, traditional main street communities, and second home and retirement communities (ICMA 2010). Some communities may fall under more than one category. Gateway communities typically occur outside of National Parks and Reserves. They provide services associated with recreation, travel, and tourism, and are generally prone to issues such as strains on infrastructure

and degradation of the natural environment. Resource-dependent communities are single industry communities whose livelihood is based around production and export of a single category of products. The main challenge for these communities is to find a means of diversifying their economy while maintaining their rural characteristics. Edge communities are located at the edge of metropolitan communities and are connected by state and interstate highways. Because these are attractive places to settle, these communities often face pressure to increase land clearing and development. Traditional Main Street communities have a compact street design and are typically considered transportation "hubs". These communities are often forced to compete with regional malls and large chain stores for local tenants to fill storefront properties. Finally, Second Home and Retirement Communities can overlap with some of the fore-mentioned communities. These communities have similar struggles in that they compete to keep up with new growth while maintaining a traditional way of life in that area (ICMA 2010).

Since the end of World War II, farm consolidation and the conversion of agricultural land for non-agricultural use has become a problem of significant importance for rural areas. According to the 2007 Census of Agriculture, 65 percent of principle farm owners report working off-farm, and 55 percent of principle farm owners report occupations other than farming as their primary source of income (USDA 2007). The loss of forest land is also changing the composition of rural areas. Between 1982 and 1997 the U.S. Forest Service estimates that 10.3 million acres of forest land were converted to developed land, and they estimate that by the year 2050 over 23 million acres of forest land may be lost (ICMA 2010). The loss of natural resources and farmland has led to an increase in occupations that require residents to make long commutes to business centers. Most rural communities do not have adequately sized roads or infrastructure to support high-density travel on a daily basis. This leads to problems with air and water

pollution, as well as logistic planning issues. As rural communities expand, the construction of new infrastructure (i.e. roads, bridges) is needed to connect new residences with financial centers and state highways. This haphazard expansion is known as rural sprawl. Land development in rural areas has the potential to be more detrimental to the environment than urban or suburban sprawl. Rural sprawl combines low housing density over large areas which results in lower development intensity than urban or suburban areas; however, rural sprawl may be more biologically significant in that it tends to occur over larger areas and the initial landscape is relatively less-altered so the impact of new construction is greater (Radeloff *et al.* 2005). The fact that rural sprawl takes place over larger tracts of land results in more habitat fragmentation and habitat loss per unit, and the number of roads connecting widely spaced residences increase disproportionately to the number of people utilizing them (Radeloff *et al.* 2005). The result of this is that communities become increasingly car and fuel dependent and require more costly infrastructure which puts a strain on local finances. Also, the "sprawling" or dispersed development from town centers makes it increasingly difficult for communities to meet their economic, social, public health, and environmental goals.

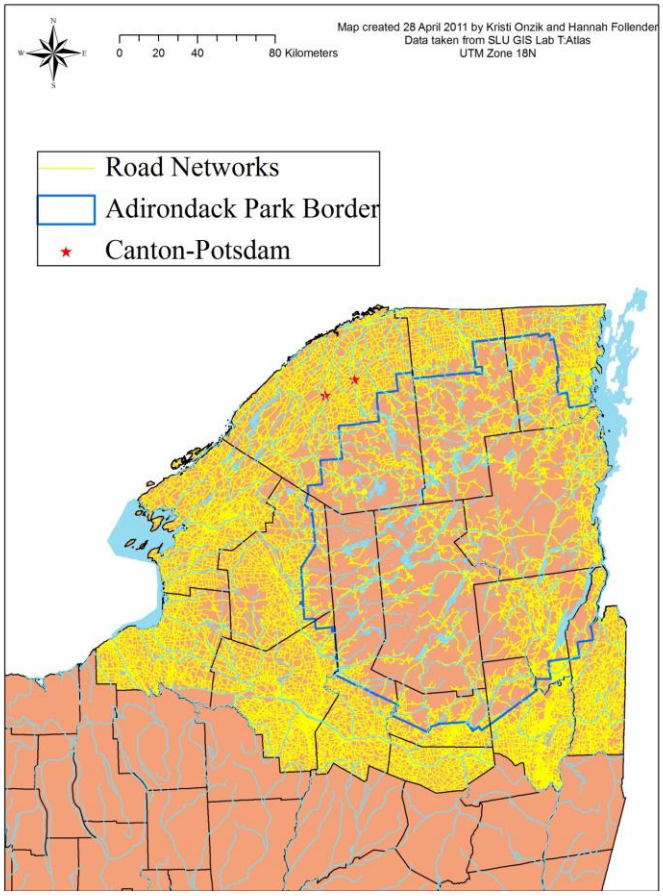


Figure 1. Road density and populated places in Northern New York State. The Adirondack State Park border is designated by the blue line.

St. Lawrence County contains 579 miles of paved roads including 118 miles of state highway, and 144 miles of county roads (St. Lawrence County Department of Highways)(Figure 1). According to City-Data.com, the population density of St. Lawrence County is 41 people per square mile. This means that the use rate of these roads is 20 people per 1 mile of roadway. The 2009 St. Lawrence County budget for road maintenance was $12,560,936 (St. Lawrence Department of Highways). So, to support 1 mile of road use for 20 people in St. Lawrence County, the Department of Highways must spend roughly $628,046. This is a substantial amount of money for a relatively low use rate per road.

Some have argued that low human population density is correlated with a low threat to biodiversity. So, in other words, rural areas are a low threat to biodiversity relative to urban centers because of their lower population density. This, however, is not true. Human population density (HPD) doesn't take into account the level of development, economic activity, and public policy of an area (Luck 2007). It is possible for HPD areas to be less of a threat because the majority of the human population of an area may be condensed into a small city-center rather than spaced out over a large area. The HPDs of a population concentrated in one part of a plot, and of a population spread out over the area of the same size plot will have the same HPD, but will have different environmental impacts. This effect can be seen in towns bordering areas designated as National Parks.

The effectiveness of protected areas depends on their connectivity with other wildlife areas and because of this rural sprawl poses a major conservation threat. The designation of an area as a State or National Park affords the area certain protections including construction and development limitations within its borders. For example, the heart of the Adirondack State Park

was designated as a Forest Preserve in 1885 by a legislative act which states, "The lands now or hereafter constituting the Forest Preserve shall be forever kept as wild forest lands… They shall not be sold, nor shall they be leased or taken by any person or corporation, public or private" (NYS Adirondack Park Agency). To this day the Park has maintained a low road density within its borders as well as a low level of development. However, outside of the park, road density and human development have continued to increase. Development outside of parks affects their connectivity with other reserves and in effect lowers their conservation value (Radeloff *et al*. 2010). Between 1940 and 2000, 28 million housing units were built within 50 kilometers of protected areas, and housing growth rates (20 percent) in the 1990s within 1 kilometer of protected areas exceeded the national growth rate average of 13 percent (Radeloff *et al*. 2010). If current trends continue, it is estimated that nearly 17 million housing units will be built within 50 kilometers of protected areas between 2000 and 2030 (Radeloff *et al*. 2010). This magnitude of development can have severe habitat fragmentation effects which ultimately degrade the biodiversity of an area.

*Importance of Biodiversity*

Although it took hundreds of years for the human population to reach one billion people, we increased to nearly seven times that size in a little more than a century. As a consequence, biodiversity, the result of evolutionary processes and events tracing back several billion years, is rapidly being lost. Few people are aware of the full spectrum of biodiversity, because our own experiences focus on interactions with people and those species that interact directly with people or attract our attention. If we are to understand the importance of preserving

biodiversity, we must appreciate the richness that lies at each level, from genes to entire biomes (Groom *et al*. 2006).

A comprehensive approach to biodiversity conservation must address multiple levels of organization and many different spatial and temporal scales; therefore, we describe biodiversity in terms of its variation in composition, structure, and function (Groom *et al*. 2006). Composition includes the genetic constitution of populations, the identity and relative abundance of species in a natural community, and the kinds of habitats and communities distributed across the landscape. Structure includes the sequence of pools and riffles in a stream, downed logs in a forest, and the vertical layering and horizontal patchiness of vegetation. Function includes the climatic, geologic, hydrologic, ecological, and evolutionary processes that generate biodiversity (Groom *et al*. 2006).

Natural biodiversity broadly promotes the provision of ecosystem functions, including those critical to human survival and well-being. Each species on Earth plays a role in keeping the planet functioning at its most efficient and productive level. The loss of just one species could bring imbalance to an ecosystem and produce devastating effects to the overall functioning and services provided by the ecosystem (Groom *et al*. 2006). A healthy biodiversity provides a number of natural services for humans including the protection and cycling of water resources, soil formation, nutrient storage and recycling, pollution breakdown, and recovery from environmental catastrophes or human impact (Groom *et al*. 2006). Furthermore, most of our technological advances in modern medicine have come from studying biodiversity. Medications like painkillers, penicillin and inoculations are based upon naturally occurring chemicals in plants and bacteria and antibiotics use living bacteria to cure diseases. According to

a study performed by Cornell University scientists in 1997, taking into account every ecosystem service supported by biodiversity including ecotourism and pollination, the total dollar value for ecosystem services provided to humans was $2.9 trillion per year (*ScienceDaily* 1997). Conserving biodiversity increases the likelihood that ecosystems can continue to provide such valuable services and serves as a hedge against environmental change, increasing the chance that ecosystems can adapt and recover following natural disturbance regimes and even climate change.

*Threats to Biodiversity*

Habitat fragmentation creates a landscape different from that shaped by natural disturbances to which species have adapted over evolutionary time (Groom *et al*. 2006). Habitat fragmentation has two components: (1) A reduction in the area covered by a habitat type, or natural habitat generally, in a landscape; and (2) a change in habitat configuration, with the remaining habitat apportioned into smaller and more isolated patches (Groom *et al*. 2006). Though the landscape matrix that surrounds habitat fragments may be suitable to many native species, or can be

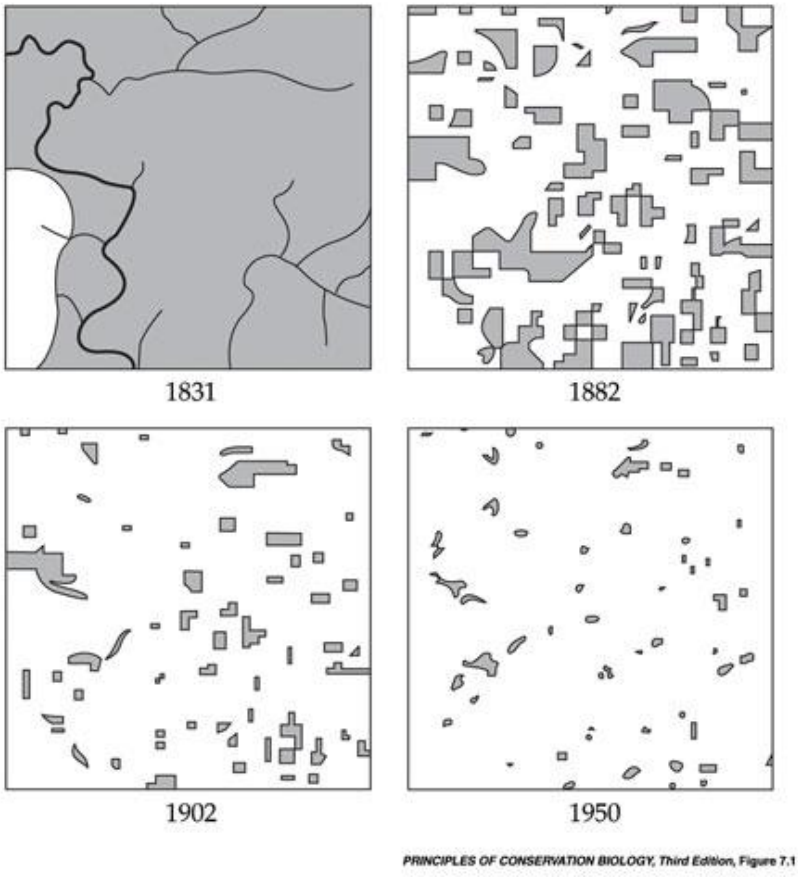


**Figure 2.** Changes in a wooded area of Cadiz Township, Green County, Wisconsin, during the period of European settlement. Shaded areas represent the amount of land in forest each year (Groom et al. 2006).

used for movement among fragments, the end result of human settlement, agriculture, or intensive resource extraction in a landscape is often a patchwork of small, isolated islands in a sea of development (Groom *et al*. 2006)(Figure 2).

There are differences between naturally patchy and fragmented landscapes; the greater the differences, the greater the threat to species persistence within them. The following four aspects of habitat fragmentation allow us to differentiate between a naturally patchy landscape and one that is fragmented (Groom *et al*. 2006). Fragmentation has resulted in a reduction of the extent and connectivity of habitats, where species may or may not adjust to this change in habitat availability and configuration. A naturally patchy landscape has rich internal patch structure (i.e. tree-fall gaps, logs, and different layers of vegetation), whereas a fragmented landscape typically has simplified patches and matrix, such as parking lots, cornfields, clear-cuts, and tree farms. Natural landscape often has less contrast between adjacent patches than does a fragmented landscape, and therefore potentially less-intense edge effects. Certain features of fragmented landscapes, such as roads and various human activities, pose specific threats to population viability.

The fragmentation process begins with gap formation or perforation of the vegetative matrix as humans colonize a landscape or begin extracting resources (Groom *et al*. 2006). The matrix remains as natural vegetation and species composition and abundance patterns may be little affected; but as gaps

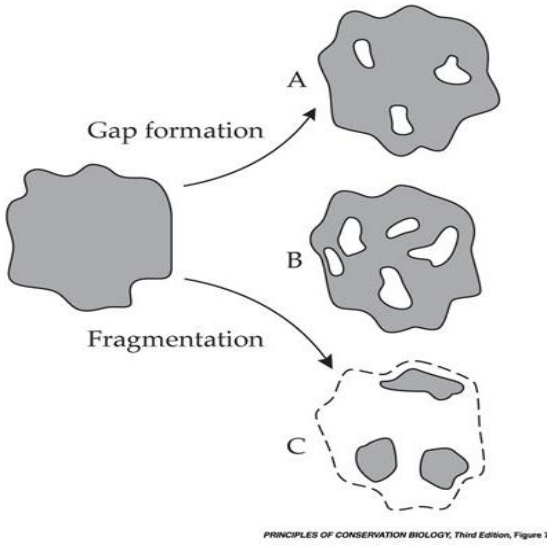


**Figure 3. A fragmentation sequence begins with gap formation of the landscape A. Gaps become bigger or more numerous (landscape B) until the landscape matrix shifts from natural to anthropogenic habitat (landscape C) (Groom et al. 2006).**

get bigger, they eventually become the matrix and connectivity of the original vegetation no longer exists. At this point, the fragmented landscape ceases to support some species. Gaps continue to grow until the landscape matrix shifts from forest or natural habitat to anthropogenic habitat (Groom *et al*. 2006)(Figure 3).

*Biological Consequences*

One of the most rapid and obvious effects of fragmentation is the elimination of species that occurred only in the portions of the landscape destroyed by development. Many rare species are endemics with very narrow distributions, occurring in very few patches of suitable habitat. If all patches of a certain type are removed, any species requiring that patch will go extinct (Groom *et al*. 2006). Researchers collecting samples of endemic insectivorous bird species in the Amazonian forest found that species richness declined dramatically within just 2-3 years after fragmentation and isolation occurred. Pre-fragmentation species richness levels were never again reached, even after forest was allowed to grow back (Stouffer & Bierregaard 1995).

As species are displaced and seek to find existing habitat elsewhere, population densities within an isolated area or fragment may initially increase. This is referred to as a crowding effect and is usually followed by population collapse due to limited resources and intense competition among members of the same species (Saunders *et al.* 1991)(Groom *et al*. 2006 Researchers found that within two years of forest fragment isolation, species richness levels of boreal birds increased within particular fragments. After two years, however, the numbers began to decline as competition for resources forced species to migrate (Schmiegelow et al. 1997). A study on crowding effects using spotted owls revealed that when their habitat was

decreased, the juveniles and adults were forced to move into the same condensed habitat area which drove competition up between the two age sets and caused the juvenile spotted owl population to decrease (Lamberson *et al.* 1992).

According to the Island Biogeography theory (MacArthur & Wilson, 1967), as the area of any insular habitat declines, so too does the number of species it contains. This theory can be applied to terrestrial "islands" or habitat fragments and is referred to as an insularization and area effect. For example, some species may face increased mortality rates when a small "island" or nature reserve may be smaller than their territory size because they are forced to travel through developed areas and unprotected areas. Some species may avoid settling in small tracts of seemingly suitable habitat altogether and become extirpated from the area or locally extinct. For example, national parks in western North America have shown that the number of extinctions has exceeded the number of colonizations since the parks were established, and extinction rates are inversely related to park area (Groom *et al*. 2006).

Isolation of habitats and populations is another harmful biological consequence of habitat fragmentation. The viability of metapopulations, or a group of spatially separated populations of the same species which interact at some level, may depend on movement of individuals between patches great enough to balance extirpation from local patches. Furthermore, many animal species require a mix of different habitats with distinct resources-for example, grazing patches and breeding sites- in order to meet their life history requirements. If these critical areas become separated by barriers, populations may decline rapidly due to increased levels of inbreeding depression and genetic drift (Andrén 1994). Inbreeding depression refers to a reduction in fitness of individuals as a result of increased homozygosity through inbreeding in a normally

outbreeding population (Templeton *et al*. 1990). Genetic drift refers to random changes in population allele frequency and decreased levels of genetic diversity due to the finite number of individuals contributing genes to the next generation. Both inbreeding depression and genetic drift result in decreased genetic diversity within a population and therefore lead to a decreased capability to resist disease and adapt to changing environments (Hedrick and Kalinowski 2000) (Lacy 1987) (Groom *et al*. 2006).

Edge effects are among the best documented impacts of habitat fragmentation and have been most thoroughly documented in forests (Fahrig 2003; Flaspohler *et al*. 2001; Debinski and Holt 2000). These effects refer to the fact that the outer boundary of any habitat fragment is not a line, but rather a zone of influence that varies in width. According to Flaspohler et al., edge effects may penetrate up to 300 m into an intact forest. Among ground-nesting birds such as the Hermit Thrush and Ovenbirds, a decreased distance to the edge (edge area increases and core area decreases) of a forest results in an increased probability of nest failure largely due to an increase in nest predation (Flaspohler *et al.* 2001). Further issues arise in forests as sunlight and wind impinge on a forest fragment from the edge, creating strong microclimatic gradients and wind turbulence (Debinski and Holt 2000). As a result, edge zones may favor plant species tolerant of dry, warm, and less shady environments than forest interiors and consequently alter the natural composition of the forest fragment (Tabarelli *et al.* 2010)(Groom *et al*. 2006).

The amount of structural contrast between habitat fragments and the matrix in which they exist is another measure of habitat fragmentation and the consequences of which are referred to as matrix effects. For many species, as the landscape matrix departs more and more from natural habitat, isolation increases as individuals are less willing or able to travel from one patch of

natural habitat to another. If the matrix is a paved road, for instance, the natural habitat within will become significantly isolated as some species are unable to or simply no longer attempt to migrate across roads. To the extent that individual animals hesitate to cross roads, roads fragment populations into smaller demographic units that are more vulnerable to extinction. Just as roads serve as barriers to the movement of species, they also serve as conduits for the invasion of others (Groom *et al*. 2006).

Invasive species are those species whose introduction causes or is likely to cause economic harm, environmental harm, or harm to human health. They often prosper as a result of habitat fragmentation because soils are disturbed and new pathways for invasion are created. Roads serve as a particularly good vessel for introducing and supporting invasive species as they disturb habitats and tend to favor species with good dispersal abilities and promote the rapid spread of nonnative weeds, pests, and pathogens. Increases in species richness at a local scale due to invasions by weedy or nonnative species are often accompanied by declines in diversity at broader scales as sensitive native species are progressively lost, even though overall species richness may remain the same or even increase (Groom *et al*. 2006).

The last of the biological consequences to be discussed due to habitat fragmentation are the effects on ecological processes. Recent fragmentation experiments, for example where dam construction has created islands of various sizes, show that the disappearance of area-sensitive predators leads to profound changes in the throughout the food web, confirming the importance of top-down regulation in these systems. Some of the strongest effects of fragmentation on ecological processes may involve invertebrates, which are critically important in decomposition, nutrient cycling, disturbance regimes, pollination, seed predation, parasitism and other natural

processes in ecosystems. Research has shown that invertebrates are particularly sensitive to disruption of microclimates which may be brought upon by edge effects which create drier habitats and a resulting increase in invertebrate desiccation (Rainio & Niemela 2003). A growing literature documents the vulnerability of animal-plant mutualisms to habitat fragmentation (Rickman & Connor, 2003;Stephens *et al*. 1999). As fragmented plant populations become smaller, they may suffer from the Allee effect, where below some threshold population size they are no longer visited by pollinators (Groom *et al*. 2006).

After discussing the biological consequences of habitat fragmentation in our current state, it is important to recognize that such alterations to our ecosystems will only be enhanced by climate change. According to Peters and Lovejoy (1992), if we add the phenomenon of rapid climate change, then we have perhaps the most ominous of all potential threats to biodiversity (Peters & Lovejoy 1992).

*Human Impact on Habitat Fragmentation*

Humans contribute to habitat fragmentation through a variety of mechanisms. The primary means of habitat fragmentation is the creation of new infrastructure (i.e. roads, bridges, tunnels). Roads lay the framework upon which housing developments, shopping centers, and manicured green spaces can occur. Roads impair species abilities to migrate, forage, and reproduce (Langen *et al.* 2009). For example, in St. Lawrence County, reptile and amphibian populations are typically lower in areas where roads are present due to high mortality rates while crossing during seasonal migrations (Langen *et al*. 2009). Populations might also become isolated on opposite sides of the road due to fear of crossing, or due to the fact that the size of the

population able to successfully cross the road and reproduce is insignificant (Lodé 2000). In places where access tunnels have been created under or over roads to facilitate the movement of wildlife, there have been observed decreases in road way mortality; however, prey species can exploited by predator species that have learned to babysit road crossing sites and this impacts the trophic structure of the ecosystem as a whole (Lodé 2000). Roads also introduce pollutants in the form of volatile organic compounds, gasoline, and oil discharge. These pollutants are soluble in fatty tissues and can accumulate in organisms and approach lethal levels as they are transferred up the food chain (Lodé 2000). The impact of roads on the forementioned species is not a result of habitat fragmentation per se, rather roads are one of the factors that creates habitat fragmentation and they have a set of negative consequences of their own.

Some studies have found that roadways impact species migration routes. Species such as wolves have been known to find plowed roads in winter to be more economical travel routes (Paquett *et al.* 1999). The presence of roads not only places migrating animals in danger of being killed by automobiles, but in some cases roads have been known to draw animals to human populated areas where they may have unfavorable interactions with people (Paquett *et al.* 1999).

Another way humans contribute to habitat fragmentation is through the alteration of large tracts of land for large scale agriculture and recreation. The clearing of land parcels of land leaves a disproportionate amount of edge habitat relative to interior habitat which particularly affects bird species (Bayne and Hobson 1997; Scott *et al.* 1995). Many migratory bird species require a large amount of core relative to edge habitat in order to nest and reproduce (Scott *et al.* 1995). The higher proportion of edge habitat causes bird species to be more prone to predation,

possibly due to the higher saturation of generalist predators in human dominated landscapes (Bayne and Hobson 1997).

Housing development, following road construction and land clearing, significantly contributes to fragmentation and carries with it a variety of negative environmental impacts in undeveloped areas. The development plan for the Tupper Lake Ski Area involves the proposed construction of 700 new housing units which would require the removal of over 100 acres of forested area. This large scale removal could cause soil erosion which would in effect degrade the water quality of the surrounding lakes and rivers (Adirondack Council 2011). The units would also be highly visible both day and night and the lights from the housing development could disrupt nocturnal animal species. Also, new construction has the potential to increase the level of human disturbance in an area. New developments often incur the construction of numerous small new roads (Hawbaker *et al.* 2006). The proposed design for improvements on the Tupper Lake Ski Area in Tupper Lake, New York is in the process of being reviewed by the Adirondack Council which has identified a series of potential threats attributed to the new design. First, none of the proposed development for the area is in the Village of Tupper Lake, or is designed to use preexisting infrastructure (Adirondack Council 2011). This will bring about the need for new roadway construction. Second, due to the distance of the proposed site from the main village of Tupper, there is no evidence that the new construction will directly benefit the town itself.

In order for this development to take place, the new construction plan involves the building of two new community sewage treatment centers. The first plant would discharge over 10,000 gallons of chemical treated effluent into Cranberry Lake, once a drinking water reservoir for the Tupper Lake Area (Adirondack Council 2011). This same water would also be used for snowmaking on the mountain which could have serious ecological effects. The second plant would discharge into Lake Simond where homeowners have recently undergone costly renovations to their septic tanks for the sake of improving the water quality of the lake (Adirondack Council 2011).

The Tupper Lake Ski Area Project represents many of the effects that a single habitat-altering plan could cause. The most common ways humans alter habitat is through land conversion and roadway construction. As explained above, these practices have serious ecological consequences not only for the health of the ecosystem, but for the health and viability of surrounding human populations as well.

*Biological Consequences and Human Impact Issues in St. Lawrence County*

Habitat connectivity is required at large spatial scales to facilitate movement of biota such as large mammals, reptiles, and amphibians, and to maintain viable populations of wide-ranging species. As mentioned earlier, roads and road vehicle traffic can alter the demography and gene flow of animal populations due to roadkill and reduce or eliminate connectivity between populations bisected by a road (Langen *et al*. 2008). The most apparent impact of roads in the Canton area is increased animal mortality due to fatal injuries from collisions with motor vehicles when crossing the road surface (Barthelmess & Brooks 2010). Vehicle-induced

mortality is directly impacting at least 50 percent of the mammal species that occur in St. Lawrence County, with an estimated 238 mammalian road-kills in the county per week (Barthelmess & Brooks 2010). Large numbers of reptiles and amphibians cross roads during seasonal migrations from hibernation or breeding sites, during natal or juvenile dispersal, and during movements between wetland and upland habitat or between wetlands (Langen *et al* 2008). Road mortality or the barrier effect of roads have shown the potential to effectively alter demographic and genetic structures of reptile and amphibian populations.

Freshwater ecosystems are heavily influenced by adjacent terrestrial ecosystems. Riparian zones are characterized as areas that interface between water and land. Examples of theses are wetlands, river banks, and lake borders. Riparian areas are often severely damaged during the land development process, leading to unintended negative impacts to our local streams and rivers. Vegetated buffers help to reduce pollution entering waterways by slowing down and filtering runoff, thus extending retention time and improving water quality. Riparian buffers also serve an important role for wildlife as a shoreline transition zone and migratory corridor (Herbert *et al*. 2010). The need for conserving and protecting our local riparian buffer zones and corridors in St. Lawrence County is supported by the following information.

According to Section 303(d) of the NYS 2010 Clean Water Act List, the following waters in St. Lawrence County have been listed as impaired and require the development of a Total Maximum Daily Load (TMDL) plan from the local government (NYS DEC). The Fish Creek Wildlife Management Area and its minor tributaries tested high in phosphorous levels stemming from local sanitation discharge into the waters. This water body ecosystem is located just one mile south of Black Lake, which has been listed since 1998 for having high phosphorous levels,

mainly due to nearby agricultural runoff. High nutrient inputs from shoreline development and agriculture can lead to eutrophic conditions, characterized by high levels of primary productivity, decreased light intensity and dissolved oxygen levels with increasing depth (Whitter *et al*. 2002). Once high-intensity primary producing algal blooms die, they sink to the bottom where they decompose and consume high levels of dissolved oxygen through the cellular respiration process. Low dissolved oxygen levels in the water can result in fish die-offs or habitat compression, pushing fish populations and other aquatic organisms to the surface where oxygen can be reached (Whittier *et al*. 2002). Habitat compression is a type of crowding effect that results in increased competition for space and food. Those species that cannot compete will die off and those that survive will experience competitive release and overpopulate. As a result, the entire trophic system will be altered and biodiversity of the freshwater ecosystem will be greatly reduced, hindering its ability to function efficiently (Whittier *et al*. 2002).

The NYS Section 303 (d) also listed the Little River and its tributaries as impaired due to high levels of priority organics being released into the water from nearby industrial pollution and landfills (NYS DEC). Priority organics include compounds such as methylene chloride, benzene, pyrene, and chloroform to mention a few. These chemicals most likely come from construction projects, roadways and fuel from cars as well

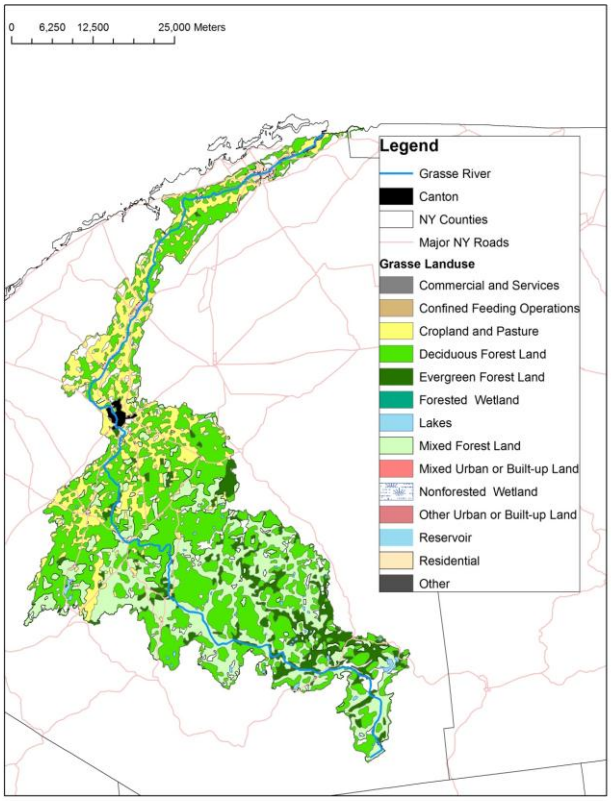


**Figure 4.** Spatial distribution of terrestrial habitats and human landuse within the Grasse river watershed (Baldwin 2011).

as from landfill seepage into groundwater which is then distributed to nearby tributaries and surface waters. Such chemicals are toxic to the environment and some are considered carcinogenic and damaging to human health if consumed either directly through drinking water or through the consumption of fish that have absorbed such chemicals into their body tissue (Whittier *et al*. 2002). Amphibian and fish species may be particularly sensitive to such chemical inputs which could cause genetic mutations, deformities, sterility, or death of entire communities. Their lack of or inability to function in the ecosystem may lead to changes in trophic dynamics and could create opportunities for invasive species to colonize, further changing the functional dynamics of the ecosystem (Whittier *et al*. 2002). As the Little River is of high natural and recreational value and is a tributary into the Grasse River, such findings should demand immediate planning of local development and protection of these important riparian ecosystems.

The Grasse River, along with the other tributaries to the St. Lawrence River, served as a water power source for several mills in the towns and hamlets along its course. Virtually none of these mills have survived, but stone foundations, burned out furnaces and other ancient structures, which are considered brownfields, can be located along its banks. Brownfields are properties, particularly under-used industrial or commercial areas that have been abandoned because of perceived environmental contamination. Considering that some of them are abandoned spaces with toxic residues still present, brownfields may become a source of harmful chemicals leaching into the river. When brownfields are avoided due to developmental complications, new businesses begin to pop up in undeveloped areas on the edges of town, increasing the issues of rural sprawl and habitat fragmentation.

Addressing these properties with redevelopment may be complicated due to the possible hazardous pollutants that may be present. Yet, reinvesting and revitalizing these properties not only helps to protect the environment, but also utilizes existing buildings, improves job growth, and creates an alternative to developing open spaces and working land.

## III. STAKEHOLDERS

There are a number of different stakeholders invested in the creation of an Adirondack to Algonquin habitat corridor and habitat defragmentation initiatives. These include local residents and private landowners, government agencies, and local land trusts. It is important to understand the unique interests of these groups in order to create a viable corridor and habitat defragmentation initiative.

### Wildlife

The local flora and fauna are key stakeholders in the issue of habitat fragmentation. They are directly affected by the impacts of fragmentation laid out earlier under 'Biological Consequences'. Species severely affected by fragmentation include habitat specialists which can only survive in a particular area under a strict set of conditions (i.e. Sedge Wren *Cistothorus platensis*), migratory species that depend on overwintering or summer plots for breeding, nesting, and foraging (i.e. Canada Goose *Branta canadensis*), and species that rely on habitat split and use two different types of habitat to complete their lifecycle process (i.e. Wood Frog *Rana sylvatica.*)

Local Residents/Landowners

Local residents and private landowners are an important stakeholder in the issue of a habitat defragmentation program between the Algonquin and Adirondack Parks. This is particularly true in the proposed corridor area, where the majority of land is privately held (Figure 4). An in depth survey of local landowners in the proposed corridor region of New York found that fewer than 50% were able to come to a conclusion regarding support or lack thereof for the A2A corridor. However, only 17% of surveyed landowners were even aware of a corridor proposal, explaining the largely undecided proportion (Brown and Harris 2005). This supports the necessity of a plan to educate the local residents and private landowners of northern New York whose knowledge will have a large impact on the effectiveness of the proposed habitat corridor.

Land Trusts

*National Land Trust Alliance*

The Land Trust Alliance is a national conservation organization representing more than 1,700 land trusts across the U.S. The organization describes its objectives as working to increase the pace and quality of conservation by advocating favorable tax policies, training land trusts in

best practices, and working to ensure the permanence of conservation in the face of continuing threats. As of August 2008, national, regional, and local land trusts have conserved a total of almost 37 million acres of land in America (Land Trust Alliance).

Conservation easements, or legal, voluntary agreements between a landowner and a private land trust that protects the natural features of the property in perpetuity, are the primary method of land conservation under the Land Trust Alliance. Such agreements are very flexible and tailored to each landowner and property, with the assurance that their land will be protected even after giving up ownership of the land through yearly monitoring by the land trust (Tug Hill Tomorrow Land Trust). A landowner may want to retain the right to farm or harvest timber, or decide that the land can only be used for low-impact recreation like camping or hiking. Such land uses will be transferred through ownership and cannot be changed. In return for setting aside land for conservation, landowners who agree to conservation easements may be able to take a charitable deduction on their income taxes, provided that the easement is granted in perpetuity, "exclusively for conservation purpose," to a qualified land trust organization. The amount of the charitable deduction is based on the value of the easement, which is determined by an appraisal that determines the property's value before and after the easement is in place (Tug Hill Tomorrow Land Trust). In addition to possible income tax deductions, conservation easements often can reduce estate taxes. Since the easement has reduced the value of the property, the value of the estate will be lower, lowering estate taxes when the property passes to heirs. Additionally, in 2006, New York State passed the Conservation Easement Tax Credit, which gives the landowner of a donated easement an annual, refundable income tax credit of 25% percent of the property taxes paid on land protected by a conservation easement, up to $5000 per year (Tug Hill Tomorrow Land Trust).

The following Land Trusts are important stakeholders in the development of the A2A habitat corridor and a northern New York habitat defragmentation initiative.

*St. Lawrence Land Trust*

The St. Lawrence Land Trust's mission is to work with landowners to conserve the ecological, recreational, historical, and cultural values of their property, for benefit of the landowner and the community (St. Lawrence Land Trust). They focus on the riparian corridors of the Oswegatchie, Grasse, Raquette, and St. Regis rivers, whose headwaters are in the Adirondack Mountains and pass through St. Lawrence County before draining into the St. Lawrence River. The St. Lawrence Land Trust is currently involved in an initiative that includes recruiting landowners to voluntarily agree to conservation stewardship plans, which provide management guidelines and best practices that preserve or improve the quality of the property. They also seek to identify landowners willing to establish conservation easements on their property that will benefit the public and secure adequate funding to complete the work involved in establishing the easement and in providing long-term stewardship. Though the St. Lawrence Land Trust prefers that land within their focus region remains under private ownership, in instances where conservation of the property is of exceptional public benefit, they are willing to consider acquiring property by donation or sale. The current keynote project of the St. Lawrence Land Trust is the Grasse River Initiative, which integrates landowner outreach, a river stewardship program, and riparian conservation easements. This initiative is funded through the New York State Conservation Partnership Program, using money provided by the New York Environmental Protection Fund (St. Lawrence Land Trust).

*Tug Hill Tomorrow Land Trust*

The Tug Hill Tomorrow Land Trust is a regional, private, nonprofit organization that primarily serves the portions of Jefferson, Lewis, Oneida, Herkimer, and Oswego counties that fall within the boundaries of the Tug Hill region in northern New York State. Their mission is to help retain the forest, farm, recreation and wild lands of the region through voluntary, private land protection efforts and to help increase awareness and appreciation of the Tug Hill region through educational efforts, field trips, and special events. To date, the Tug Hill Tomorrow Land Trust has worked with 33 land owners to protect over 5,000 acres of land in the Tug Hill region through legally binding conservation easements.

*Indian River Lakes Conservancy*

The Indian River Lakes Conservancy is a non-profit organization operating under the Land Trust Alliance that was formed to conserve critical lands in the Indian River Lakes area of northern New York. Their mission is to preserve the natural character of the area, with a focus on protecting clean water, fish and wildlife, and the scenic vistas along the shores of the lakes and the Indian River and to educate the community about the natural habitat in which they live. The IRLC is currently working on two major grants, one for $25,000 to expand their outreach to the community and another from the Great Lakes Restoration Initiative, funded and administered by the US Fish and Wildlife service, for over $440,000 to purchase three parcels totaling more than 500 acres of significant waterfowl and wildlife habitat within the area. Two of these parcels are contiguous with existing NY State and IRLC owned lands, further expanding the footprint of these protected areas.

*Thousand Islands Land Trust*

The Thousand Islands Land Trust (TILT) conserves over 7000 acres of land in the Thousand Islands region of New York State, which includes the islands in and the shoreline along the St. Lawrence River between Cape Vincent, NY and Oak Point, NY on the US side of the Canada/ US border. Roughly half of the 7000 acres is privately owned land subject to conservation easements held by TILT. The other half is land that is owned by TILT and includes recreational areas open to the public as well as protected wetlands, forests, grasslands, rocks and shoals in the St. Lawrence River, and land donated to TILT for its scenic qualities. Partnering with other agencies and organizations, TILT has helped to restore a variety of important habitats in the region, including the restoration of nesting habitat for Common Terns, reclaiming open fields for grassland species, and protecting wetlands and other nursery areas for aquatic species.

Government Agencies

*St. Lawrence County Planning Board*

The St. Lawrence County Planning board is based in Canton, NY and provides a wide variety of services including grant writing and administration, especially in housing and local infrastructure, technical assistance to local governments and citizens on planning and zoning and environmental problems, and to monitor and respond to state and federal project proposals and laws. They play a key role in assisting towns and villages with identifying priorities, goals, and objectives for the future of communities through the preparation of community development plans.

*NYS Department of Environmental Conservation*

The NYS Department of Environmental Conservation (DEC) is responsible for the conservation, improvement, and protection of natural resources within the state of New York. The Department manages the Adirondack and Catskill Forest Preserve lands, state forest lands, wildlife management areas and various other state owned public lands of New York. The Department is also responsible for regulating sport fishing, hunting and trapping within the state, and enforcing the State's environmental laws and regulations. The NYS DEC has an annual budget of approximately $1 billion and manages over 4 million acres of protected state-owned land and another 690,000 acres of privately-owned land on which it holds conservation easements.

## IV. GOVERNMENT ISSUES

The means through which government and state agencies designate and regulate protected areas is primarily comprised of statute regulation as opposed to common law which solely depends on the outcome of court cases to apply remedies. Courts threw out the use of the nuisance claim under common law in the 1960s because it limited the police power of the state. A nuisance is a substantial interference with the right to use and enjoy land which may be caused intentionally, or simply due to negligence. A result of this was that zoning laws become more heavily relied upon to control the human alteration of landscapes. Post World War II, the preservation of land for open spaces became the main focus of the use of zoning laws. However, many open-space ordinances had loop holes that allowed for paved trails, private yards, and landscaped areas to count as open space. The New York State Open Space Conservation Plan

defines “Open-Space” as, “land which is not intensively developed for residential, commercial, industrial, or institutional use…It includes agricultural and forest land, undeveloped coastal and estuarine lands, public parks and preserves…a vacant lot or small marsh can be open space in a big city, and a narrow corridor for walking or riding a bike is open space even though it is surrounded by developed areas” (NYS Open Space Conservation Plan 2009). Conventional open space zoning tends to be density dependent, meaning that the focus is to maintain a suburban landscape and prevent the development of a heavily trafficked urban center, rather than to maintain the biodiversity of an area.

The Takings Clause is a constitutional amendment vital to the establishment of protected areas. The Takings Clause holds that no private property can be taken by the government for public use with public funds unless just compensation is given. For example, a local government that seizes land near a river from a private owner must provide evidence that the taking was done for the public good, and that the party from which the land was taken was rightfully compensated. Takings should only be undertaken by environmental institutions when the land to be seized is vital and there is no other way to obtain the land; these cases are often prone to heavy legal debate and can cause the public to view environmental efforts in a negative light. Instead, programs that incorporate voluntary public participation with the objectives of environmental organizations can be more beneficial (i.e. landtrusts).

In most states—and under the proposed federal conservation funding programs—there is no link between the investment of funds in conservation lands and the protection of those investments from negative impacts resulting from private and governmental actions on nearby lands. For example, state land acquisition programs have established protected easements along

river banks but have neglected to provide any means for mitigating effects from zoning and land-use development provisions that affect the land immediately adjacent to the protected buffers. State land acquisition funds have been used to acquire bogs with rare plants, while development on upland areas has continued under local rules that do not protect the conserved area from damage due to runoff. The outcome of many of these acquisition programs has been, and will continue to be, the purchase of isolated fragments of green space, coastal marsh, mature hardwood forest, or prairie, which will then be surrounded by sprawling residential housing on one-acre lots, strip malls and office parks, and roads running to and even through key habitat corridors.

Government land easement programs work by offering tax breaks in exchange for land. Once the land is under consideration for easement status, a survey is done to assess the value of the land for tax purposes. The current system conveys state and federal tax breaks to the owner of the land who initiated the easement. However, only the federal tax break rolls over to the new owner of the land, while the portion of the property under control of the easement remains under permanent restrictions (Barthelmess interview). In effect, new owners of a land containing an easement must accept a loss of land value. This can deter private land owners from entering into easements if they perceive the loss of value of their land to be significantly detrimental to future plans to sell their property, in other words, landowners might prefer to sell their property rather than incur the risk of making less money.

In New York State, the 2006 Conservation Easement Tax Credit gives New York State landowners a 25% annual refund of property taxes paid on land under easement up to $5000 per year (NYS DEC). In June 1998, a federal tax bill extended the federal estate tax benefits for

donated conservation easements. The estate tax exclusion was filed under section 2031 (c) of the Internal Revenue Code (Land Trust Alliance). This allows for an estate tax exclusion of up to 40% of the value of the land protected under a conservation easement (Land Trust Alliance). This refund is capped at $500,000 and is further reduced when the value of the land under easement reduces the value of a property by less than 30% (Land Trust Alliance).

## V. PARAMETERIZING SOLUTIONS

To effectively address habitat fragmentation caused by rural sprawl, there are six important factors that should be taken into consideration when devising a plan. First, the program itself and the agency in charge of implementing it should not be affiliated with the government. The public tends to view government imposed environmental restrictions as oppressive and overreaching. In St. Lawrence County, numerous government interferences in past years that have negatively impacted the livelihood of residents in the area have resulted in a significant level of government distrust. The Power Authority Seaway Project began in 1954 and was completed in 1959. This project involved the construction of a hydroelectric dam between Cornwall on the Canadian side of the St. Lawrence River, and Massena on the New York side. Following the dam, golf courses, shopping centers, and airstrips were among the new construction that the Power Authority had undertaken on land they had seized along the river from local residents and farmers, some of whom had lived there for generations (Montan interview). Another instance of government taking in the North Country is the Fort Drum Army Base. That land was seized by the government to develop a cold climate training ground for the military. These types of land takings had made people so nervous about government interference that when a five-part wildlife preserve was proposed in the area, the public immediately rejected

the plan because they viewed it as a government scheme to deprive them of more land and rights (Montan  interview). In a North Country Public Radio show, North Country residents were interviewed about their participation in a defragmentation program known as Wildlink. The Conservation Resource Alliance, the agency in charge of the Wild link project, said that though government agencies do offer corridor and defragmentation programs for homeowners to be involved in, many private homeowners do not want to be pawn to government regulation and would instead prefer to work with a private group.

Since a government program does not seem to be an effective approach for conservation, it follows that a higher level of community involvement is necessary. When people are involved in the planning process, rather than have a program imposed on them, they may be more likely to support the goals of the program and be more willing to help. It is difficult for conservation agencies in general to oversee all of the lands under their care. Public support and involvement could potentially help ease the burden of making sure that all conserved lands are properly protected. If the community sees themselves as having a stake in it, then the program should have a greater chance of succeeding.

The next requirement for a successful program is that it should include a comprehensive system for regular upkeep and regulation of areas protected under the program. In many cases, government programs responsible for drawing up conservation easements will not follow up on land they have designated for protection. This leaves conservation lands open for exploitation through activities that were explicitly prohibited by the easement contract. Also, assessments of lands surrounding easements should also be done to protect the integrity of the protected land and ensure that the easement is not violated due to impacts from surrounding land uses

(McElfish 2002). For example, state land acquisition programs have protected wetlands, bogs, and rare plant species in riparian areas, yet they have failed to regulate harmful activities upstream from these areas, which in effect makes their protection efforts ineffective.

When devising a plan for habitat conservation, it is often difficult to determine which areas should be given priority over others. While a small tract of land may be beautiful or provide important habitat for a few species, its benefits might not outweigh the costs of creating it if it is isolated from other natural areas by developments and land alteration activities. As described in the biodiversity section above, habitat connectivity is important for the viability of species due to the need for gene flow. Without this, species may be prone to insularization effects including inbreeding which can lead to population decline and eventually extinction. Lake and river networks provide a natural map of connected habitats which make them an ideal target for conservation projects and habitat defragmentation programs. Riparian zones are vital, as both aquatic and terrestrial species depend on them for a variety of services. In the North Country, many animals including black bears, otters, and bobcats rely on riparian migratory routes (Graham  interview). Wetlands provide important biologically diverse habitats and help regulate river systems (Herbert *et al.* 2010). Riparian areas are highly important for the purpose of plant seed dispersal, and their importance increases during times of climate change due to the presence of better microclimate habitats along riverbanks (Gregory *et al*. 1991). Despite their ecological importance, protection of riparian corridors is relatively low due to their historical use for commerce and agriculture (Herbert *et al.* 2010). For these reasons, a successful defragmentation program should establish large tracts of riparian zones as priorities for conservation.

Finally, the purpose of defragmentation is to develop a large degree of habitat connectivity. This connectivity should be considered regionally as well as locally. Many plant and animal species have large ranges that cannot be fully protected under exclusively local programs. This means that collaboration between neighboring towns, counties, states, and even countries is necessary. One such regional group has taken on the task of establishing a habitat corridor between protected areas in Canada and the United States. This program is called Algonquin 2 Adirondacks (A2A) and their mission is to create a habitat corridor between the Algonquin Provincial Park in Southeastern Ontario, Canada and the Adirondack Park in Central New York State. The Algonquin Park consists of 7,725 kilometers of protected land. The park is considered a transitional zone between deciduous and coniferous forests and provides habitat for over 8,400 plant and animal species (Algonquin Provincial Park). The Adirondack Park covers 6 million acres of land, 2.6 million of which is designated as forest reserve land (NYSDEC). Many of the species found in the Adirondack Park are also found in the Algonquin Park in Ontario. The aim of the corridor is to use the Frontenac Link to allow for species to move between the two parks. The Frontenac Link is the focus for the

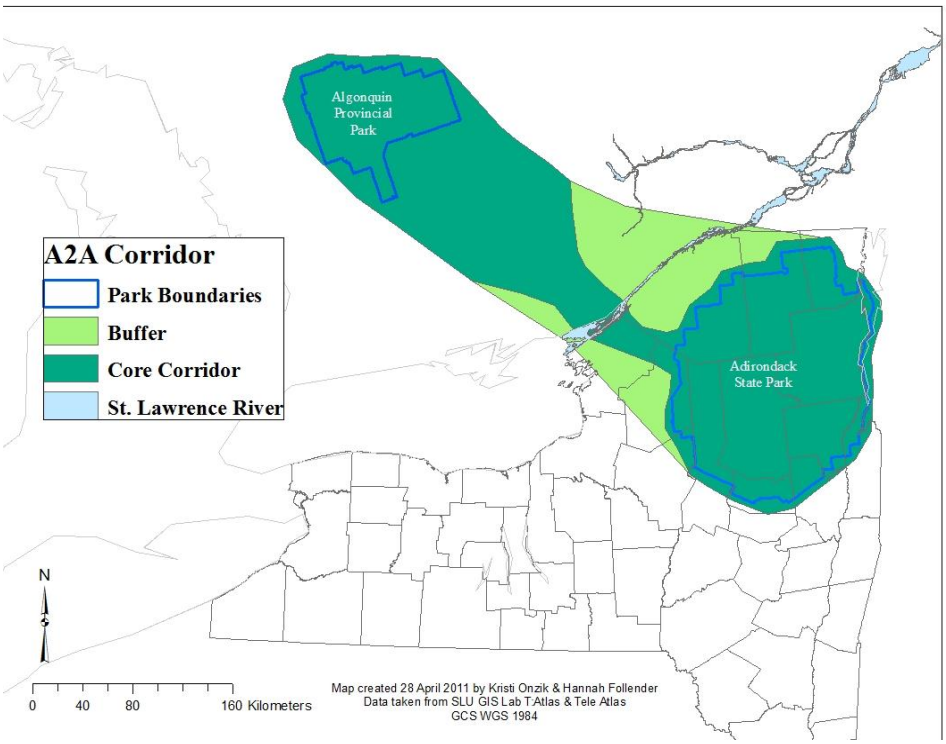


**Figure 5. Map of the A2A corridor between the Algonquin Park in Ontario, Canada and the Adirondack State Park in New York State. The core corridor area is designated by the dark green, and the edge corridor area is designated by light green.**

corridor because it contains the Frontenac Axis, the least degraded north-south corridor across the St. Lawrence River (Quinby *et al*. 1999). The land bridge created by the Frontenac Arch is considered an important region for providing habitat connectivity between the Algonquin and Adirondack Park regions. More than 50 mammal species occur in this region, and nearly 200 birds may breed here with the Frontenac reserve serving as a connection between their Northern and Southern ranges. Furthermore, the area comprises islands and islets of the Saint Lawrence River which act as stepping stones for the seasonal migration of numerous species of plants and animals that make this area all the more crucial to conserve. Connecting these two parks would facilitate the movement of long ranging species native to the area (timber wolf, marten, lynx, moose) that have been extirpated due to habitat division and loss.

A defragmentation program in St. Lawrence County should give a substantial amount of consideration to incorporating A2A goals into their program because the core corridor habitat runs through the southern part of the county to the Adirondack Park. Also, while the Village of Canton does not fall in the core habitat area, it does fall in the buffer zone. This area is extremely important for maintaining the integrity of the entire corridor because it protects the core habitat from interference by providing a soft edge transition.

## VI. SOLUTIONS

The fragmentation of land is a direct result of human development, be it by roads or the alteration of land for agriculture or commercial use. The key problem lies in economic deficiencies, and is further exacerbated due to poor planning and a lack of community

involvement. The solutions we have explored to remediate the fragmentation issue deal primarily with improving economic integrity in order to raise the environmental welfare of the area.

*Conservation easements/Tax Credits for Conservation*

For any land whose conservation is in the public interest, a conservation easement is a legal agreement that permanently limits the uses of privately owned land in order to protect its conservation values. This allows the landowner to continue to own and use the land and to sell it or pass it on to their heirs. There are tax advantages to landowners for donating conservation easements, including both immediate property tax and inheritance tax benefits.

Federal, state, and local governments can grant tax credits for land donation or conservation easements. For example, Colorado has a tax credit system in place that provides the donor of a conservation easement a state income-tax credit of one-half the dollar value of the land under easement, up to an annual maximum of $375,000.

*Cluster Development*

While at times controversial, cluster development can be an alternative to large lot, dispersed subdivision development. The basic premise of cluster development is that a developer can build the same number of units on smaller lots while preserving a percentage of the developable land for agriculture or as natural habitat. Cluster development is a solution to reduce rural sprawl and create what is known as a "conservation subdivision." The implementation of a conservation subdivision typically occurs through open space zoning or an

overlay district such as a cluster or planned unit development ordinance. The conservation subdivision has many compelling environmental and economic advantages, like reducing infrastructure costs and making it cheaper to provide community services while also limiting loss and fragmentation of wildlife habitat. State or local governments can aid in the solution of habitat fragmentation and rural sprawl by purchasing land outright in order to conserve particularly important land.

Cluster development has become popular in a number of states, notably Massachusetts, where towns like Mashpee, on upper Cape Cod have revised zoning codes to require that at least 50 percent of new development sites be preserved as open space. This means that for example, on one acre of property, only half an acre may be converted or developed. Another notable example is King County, Washington, home to Seattle. Through its green building guidelines, King County promotes rural home clustering in order to minimize their environmental impact and disruption of the landscape. In order to facilitate rural home clustering within rural area and urban reserve zones, King County offers a critical areas designation, which allows landowners and developers to define critical areas near the project site and to use Build Green™ grants for community and multifamily developments as well as for single-family homes (King County Solid Waste Division). Furthermore, according to a study performed in southeastern Pennsylvanina, the conservation of open space was found to add approximately $16.3 billion to the value of their regional housing stock (Green Space Alliance 2010). They found that while homes that are closer to open space enjoy a more significant property value increase, on average, all homes in the southeastern Pennsylvania region are worth $10,000 more because of access to open space. When added all together, it's a gain of more than $16.3 billion for the region's homeowners and economy.

The above programs are reactions to areas that have already been heavily developed. In rural communities that are in the process of being developed, these retroactive practices can be avoided by incorporating environmentally conscious planning into current development schemes (i.e. cluster development or Smart Growth). It is important to implement this cluster development now to prevent the need for rigorous defragmentation programs in the future.

*Value-Added Farming and Forestry*

One solution for balancing economic growth with the conservation of open space is for St. Lawrence County to increase the processing of raw food and fiber into value-added products which allow for landowners to supplement their income beyond simply selling raw materials. Due to mass-producing large scale farming and forestry industries, both raw agricultural and forestry products have diminished in price, making it extremely difficult for small farms to compete and make a profit. Adding value to their products is a method of supplementing the small farmer and forestry business incomes and supporting their sustainable use of resources and contribution to healthy ecosystem functioning.

Supplementing the income of small scale agricultural and forestry businesses would benefit our local ecosystems by supporting small scale harvesting and resource use, preventing soil erosion and pollution of local waterways as well as the development of more roads and habitat destruction. Value-added forestry products include furniture, flooring, construction materials, and paper; value-added food products include yogurt, cheese, or ice cream made from milk produced at a local dairy farm.

*Development of Renewable Energy*

Another solution is the development of renewable energy on rural lands which would provide farmers and foresters with increased profits from their land, giving them an additional economic incentive to "keep working lands working." Some lands are suitable for wind energy development, and landowners may be able to capitalize on the opportunity to enter the energy market while still maintaining the traditional use of land. Federal investment tax credits for wind farm development, including the Production Tax Credit, can provide an economic incentive to landowners. Another method of renewable energy development is biomass production from trees, crops, or livestock manure, which can be processed by a methane digester to generate electricity for the farm or for sale to the grid. A successful example of such a project are the Rural Renewable Energy Development zones in Oregon, which encourage development of renewable energy resources in the area. Energy companies developing renewable capacity in RRED zones receive a property-tax exemption for three to five years.

*Ecosystem Service Market*

In addition, rural lands provide valuable ecosystem services, including sequestering carbon, filtering and storing a clean water supply, maintaining a habitat that supports biodiversity, and mitigating natural hazards, such as floods and fires. In an ecosystem service market, a landowner can sell their ecosystem service credits to a bank, which in turn can sell them to a buyer that has exceeded limits in carbon emissions, water pollutants, or biodiversity

loss. A famous example of an ecosystem service market is the New York City watershed project known as "Whole Farm Planning." During the 1980's, agricultural and forestry development in the Cat-Del watershed led to non-point source pollution of NYC's previously "pristine" drinking water. After several years of debate, farmers and foresters within the Cat-Del watershed agreed to the establishment of the "Whole Farm Planning" program, which involved the City paying both the operating costs of the program and the capital costs for pollution control investments for each farm and forestry business involved. Over 93 percent of farmers in the watershed chose to participate in the plan within the first 5 years of establishment-even farmers outside of the watershed's boundaries ask how they can become involved. Whole Farm Planning is considered to be one of the most successful non-point pollution control programs in the U.S., and its results have played a major role in enabling the City to avoid the multi-billion dollar cost of filtering the Cat-Del water supply.

## VII. IDENTIFICATION OF FEASIBLE SOLUTIONS

The five possible solutions laid out above all have the potential to address the problem of habitat fragmentation, yet some of their limitations affect their feasibility as implementable options.

*Cluster Development*

Cluster development is an economical means of development in that it stresses maintaining development within close proximity to itself rather than outward expansion from a central point. By doing this, cluster development reduces sprawl and encourages the

development of a vibrant downtown which can lead to business development and job creation. Studies have shown that homes closer to large open space areas enjoy significant property value increases, so it is economically beneficial to leave large un-fragmented natural areas outside of compact town centers (Green Space Alliance 2010). Also, cluster development decreases pressure on undeveloped open space and decreases the amount of disturbance experienced by species inhabiting the area. The closer proximity of businesses and homes should lead to a reduction in daily transportation and travel expenses, which could also result in social and emotional benefits such as increased time for family and leisure activities. Community involvement in planning is an important part of cluster development so this project would rely on feedback from community members on issues like transportation and business center design.

The barriers to cluster development include the unwillingness of individuals to live in relatively closer proximity to their neighbors than they currently do. Some people might prefer to keep their properties adjacent to large open spaces because of the value that their individual parcel of land holds for future sale. People also may reject encouraged relocation by village or county government, and this is why community participation is so vital to this program's success. One possibility is to provide tax incentives to encourage people to move into cluster development type areas which might be favorable in a low income area such as St. Lawrence County. Also, the revitalization of town centers and new construction is costly so grants and other forms of funding will have to be secured.

*Processing of Raw Materials*

The processing of raw materials promotes conservation through managed resource use. This practice allows small farmers to supplement their income and compete with large farms. Support for small farmers could help them avoid the need to sell out to developers whose actions would potentially pose a greater environmental threat. This plan does not rely on government involvement so it would ease concerns of those skeptical of government intervention. This is a small scale community project so it does not require a large group in order to be effective. Also, this strategy allows for the management of specific ecosystem resources.

The drawbacks of this plan are that it may be too small scale to make a difference. This seems to be more of a supplementary plan rather than a focal plan, so it is not big enough to impact large open space conservation.

*Development of Renewable Energy*

The development of renewable energy provides the opportunity for farmers and areas with human altered open space to make their lands more profitable. Wind-farms and bio-fuel development can bring economic growth to an area. Also, it can increase local awareness for environmental issues and could foster participation in the development of local sustainable practices.

While the development of renewable energy is important, there is a chance that the economic benefit derived from it may not be distributed equally. For example, projects, like wind-farms, may be undertaken by large companies, and lands may be selectively chosen so some benefit while others don't. Energy programs usually incur a heavy amount of government

involvement which could upset those people who do not feel comfortable with government interference. Finally, while the development of renewable energy sources could reduce energy drain and pollution, it does not necessarily contribute directly to habitat connectivity. In fact, the development of sites for the production of renewable energy can lead to habitat fragmentation and destruction due to the need for access roads and land clearing for wind turbines. In Malone, NY, a wind farm was built to take advantage of the naturally windy climate of the area. Trees had to be cut down and roads had to be built to allow for the implementation of this project. The creation of wind farms requires large tracks of cleared land which could result in increased air and water pollution due to erosion, and the reduction of the scenic quality on an area (Wilshire and Prose 1987).

*Ecosystem Service Market*

In an ecosystem service market, open space is preserved to provide naturally provided ecosystem services that cannot be replicated at a manageable cost. Through this market, specific habitats in need of protection can be focused on (i.e. riparian habitats). However, as a market system it would be prone to government control and involvement in the form of regulations and restrictions. Also, it allows resource use per the ability to pay. This would disenfranchise the low income community in St. Lawrence County and allow large companies to continue to take advantage of small towns with strapped budgets by polluting and misusing local ecological services in exchange for money. This could potentially result in severe losses in ecological services. Once the companies have fully exhausted those resources, the flow of money for use of these resources will cease to exist and the local people will be left worse off.

*Conservation Easements*

Conservation easements are extremely useful tools for environmental conservation because they are legally binding and permanent. Easements allow for tax incentives to be given to people who are willing to designate a portion of their land as protected area. That tax incentives are attractive to those with low use land or minimal profit agriculture land. Easements can be administered by a private organization rather than through the government which may make landowners feel more at ease. Also, through easements conservation groups can select for habitats of interest and priority areas that need protection which allows for ecosystem based management. Easements are also useful for contributing to the A2A corridor and buffer because the majority of land held between the two parks in New York State is privately owned (Figure 5).

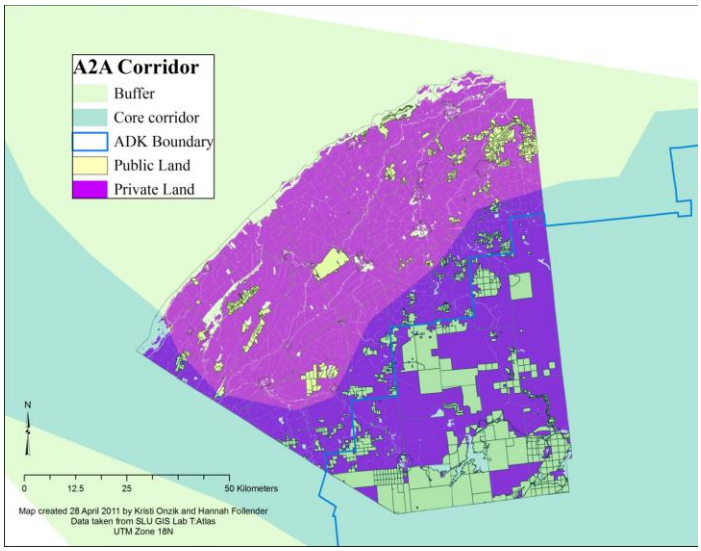


**Figure 4. Publicly and privately held lands in St. Lawrence County and their orientation within the proposed Algonquin to Adirondack corridor.**

The limitations of conservation easements are that people may be unwilling to give up land or accept a loss of resale value. Some landowners may be skeptical of outside control regardless of whether they deal with a government group or with an agency unaffiliated with the government. Land put under control of easements needs regular review to make sure prohibited activities are not taking place within protected areas and this requires man-power,

time, and money. The process of creating an easement is also costly due to legal fees and surveyor fees.

While the federal estate tax breaks have been extremely important for conservation, the increasing value of property has led the $500,000 cap to become inadequate. According to the USDA, between 1997and 2010 the value of farmland increased 133% per acre. Large farms and ranches typically affected by estate taxes are more likely to contain important ecological resources and are typically economically sustainable (Land Trust Alliance). Because of this, greater financial incentives may be needed to encourage the owners of these large profitable lands to register portions of their property as conservation easements.

## VIII. IDENTIFICATION OF BEST SOLUTIONS

Our best solution has been found to be one that combines the qualities of a cluster development program with conservation easements. Cluster development takes into account the need for economic growth and the consideration for the well-being of the people living in St. Lawrence County, particularly Canton. Reviving downtown Canton through beatifying the business district could help attract new businesses to the area which would in turn produce jobs.

Encouragement of housing development in Canton proper would support a decreased daily need for long distance travel to work. Also, a reliable community shuttle system could be implemented to decrease road traffic and air and water pollution. Bike lanes could also be incorporated into city streets to encourage bike traffic.

Conservation easements can be used to encourage land preservation by offering tax incentives such as immediate property tax and inheritance tax benefits. The local land trust has already taken up job of establishing easements. The establishment of a rural development tax could be used to fund local land trusts and alleviate the costs of creating conservation easements.

The Vermont Land Trust has managed to place 8% of all privately held land in the state under conservation easements. In doing this they work to preserve not only undisturbed habitat, but small agricultural family farms in an effort to preserve the culture of the state. They have also created the Vermont Housing and Conservation Trust to help ensure that affordable housing remains available in rural communities. A program like this could be taken up as a coordinated effort between the local land trust and the Canton Town Planning office to ensure affordable housing for low income residents. These people might otherwise opt for housing farther away from the city center because of the draw of cheaper land, however, it would be more economical and environmentally sound to provide them with housing areas close to the downtown business district.

## IX. IMPLEMENTATION

The first step for a community wanting to improve its growth pattern is to assess the current environmental, economic, and social conditions. How is the community connected to other communities in the region? What are the community's best assets? Its key challenges? Then, residents, leaders, and other stakeholders can decide what the community's long-term vision is—what kind of place it should be. Defining the community's vision for the future involves identifying the community's highest priorities, most valuable resources, significant

aspects of its identity, and so on. Once there is some agreement on the end goal, the community can determine the necessary approach to help realize that vision.

State and federal funding programs can be designed to require that conservation funding be provided only where land use plans are in place and future local land uses are compatible with the conservation investment. Or conservation funding programs can use sustainable land use as a scoring technique in competitive grant programs where areas with compatible planning and "smart growth" approaches are more likely to receive funding. These techniques can ensure the performance of the conservation investment and can take advantage of the full potential of funding to encourage improved local performance.

## X. STEP-BY-STEP IMPLEMENTATION

The first step for defragmenting and protecting existing natural habitat and open space in the North Country is to establish a permanent conservation funding body (i.e. Garden State Preservation Trust of New Jersey) which distributes funds (i.e. tax money) to those programs that have adopted an open space conservation and development plan. Potential available funding organizations in New York State include; the Environmental Protection Fund, the NYS Department of State, Adirondack Smart Growth Grants, State Wildlife Grants, State Revolving Loan Fund, Community Preservation Act, and the Local Bond Act. St. Lawrence County one of the poorest counties in New York State (St. Lawrence Land Trust) and therefore it is imperative that funding for conservation programs is distributed from state, federal, and private grants. Though conservation easements and cluster development programs are costly, they have the potential to provide the greatest long-term benefit to both the community and the environment.

State and federal funding programs can be designed to require that conservation funding be provided only where land use plans are in place and future local land uses are compatible with the conservation investment. This can be done by simply outlining requirements that must be met before the funds are dispensed which is a process already in place for many state and federal grant programs that St. Lawrence County has yet to apply for. Or conservation funding programs can use sustainable land use as a scoring technique in competitive grant programs where areas with compatible planning and "smart growth" approaches are more likely to receive funding. These techniques can ensure the performance of the conservation investment and can take advantage of the full potential of funding to encourage improved local performance.

A community that seeks to develop a conservation and development plan needs to assess their current environmental, economic, and social conditions. What are the major land use patterns in the area? What areas are of highest priority for conservation? What are the community's best assets? Its key challenges? This would involve the professional biological assessment of important ecosystems and habitats in the region maintaining the highest priority for protection. Then, residents, leaders, and other stakeholders can decide what the community's long-term vision is—what kind of place it should be and how it will combine environmental protection with economic development. Defining the community's vision for the future involves identifying the community's highest priorities, most valuable resources, significant aspects of its identity, and so on. Once there is some agreement on the end goal, the community can determine the necessary approach to help realize that vision and apply for state or federally funded grants.

In order to encourage cluster development, stricter zoning laws will have to be established by local municipalities that limit large scale development, and limit new

development that requires land clearing for the construction of new infrastructure. Stricter zoning can benefit the community by increasing the market value of land due to a greater amount of open space and produce a non-market public good in the form of ecosystem services (Butsic *et al.* 2010). The transfer of development rights (TDR) can be used to reassign developers to areas that do not pose a serious environmental threat if altered. In this method, development rights are transferred from an area of undeveloped land to develop in another area. Some states that have instated TDR programs provide incentives to developers who comply and transfer their operations away from natural areas. In Montgomery County, Maryland, developers who purchase TDR bonuses are allowed to build at higher densities, and the funds from the purchase of these rights are used by the municipality to purchase local conservation easements (ICMA).

Conservation easements are an important part of the TDR program and are also important for encouraging cluster development. The money gained by the municipality from TDR program purchases by developers should be designated for the purchase of easements. The municipality (i.e. Village of Canton) should give the funds for easements to their local land trust (i.e. St. Lawrence Land Trust) for the purchase of easements because land trusts are knowledgeable about lands that should be considered priority conservation areas. Also, the purchase of easements should be solely undertaken by local land trusts because they are not government agencies. Dealing with local land trusts rather than government affiliated organizations makes for a more personal transaction and avoids trust and communication issues that have historically persisted between private landowners and the government.

## XI. CONCLUSION

The fate of the earth's biodiversity is inextricably linked to the fate of natural habitat. Habitat fragmentation is one of the most widespread and pervasive human activities. A plan that includes both cluster development and conservation easements may provide the greatest benefits to both the environment and local community. This plan is easily compatible with the A2A corridor since the designation of private lands for easements and the control of rural sprawl through clustering has the potential to contribute to greater habitat connectivity. Large, interconnected nature reserves are only part of the solution to the fragmentation problem. Entire landscapes, including private and multiple-use public lands, should be managed in ways that minimize destruction and isolation of natural habitats.

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