Spring Creek Valley Ecological Assessment
Report
12-29-06

Background

The Spring Creek Valley is an extremely unique area in the county and the state. The creek itself is a world-class trout fishery and hatchery, because it is enriched with minerals from the surrounding subsurface limestone geology, and because it is surrounded by natural vegetation that helps preserve the water quality. There are very few areas of limestone-based, high-pH soils remaining in natural vegetation, as this soil type tends to occur in low, rolling or flat valleys that have largely been converted to agricultural or other uses. For the same reason there are also very few remaining areas of lowland forest along mid-sized and larger waterways. The Spring Creek Valley's dramatic topographic relief results in many different combinations of slope, aspect, and elevation that provide habitat for a diverse spectrum of natural communities- from dry limestone cliffs in exposed, steep, south-facing areas, to hemlock forest on north-facing coves of moderate slope, to floodplain forests in low, flat, creekside regions. Because of the limestone surface geology, these communities tend to have a very diverse species composition, and host many species that do not live in other areas. These include populations of several plant and animal species of special concern in Pennsylvania. Spring Creek Valley was given the highest ranking ("Exceptional Significance") as a Biological Diversity Area in the Centre County Natural Heritage Inventory report of 2002.

The Spring Creek Valley's importance to human communities and to the region's ecological health is heightened because it is an extensive natural area within a matrix of agricultural and increasingly urban land. It provides a refuge for wildlife and for people. However, its small size and its isolation from other natural areas poses grave problems for its long-term viability. The naturally vegetated areas along the creek are in most areas confined to a narrow corridor along the steep slopes of the valley. Forest edges (up to 100 m from a non-forested area) have different physical characteristics than interior forest, and edges cannot be utilized as well by many forest species (Matlack 1993). Forests of a small size have a high ratio of edge to interior area, and thus provide only very small patches of usable habitat for many species (see Figure 1, map of edge & core forest habitats in Spring Creek Valley). These small areas support only small populations of many species, which leaves the population very vulnerable to elimination by chance events and may also limit genetic diversity (Seiler 2001). Because there are no natural corridors connecting the area to nearby forests, species that cannot move across large expanses of agricultural or urban land will not be replenished if they are lost. Additionally, many bird species will not breed successfully in forests less than 600 acres in size (Lynch & Whigham 1984; Robbins et al. 1989; Robbins 1980). Although there is a great diversity of plant and animal species currently present in the Spring Creek Valley, the long-term viability of these populations is seriously in question due to the small and fragmented nature of the forests in the valley.

The natural habitats of the Spring Creek valley are also threatened by the invasion of exotic plant species. Many invasive shrub and herb species are present in the valley. In areas of recent regeneration, and in many areas along roadsides and the stream bank, these species predominate. They are also present in lower densities in many more mature communities, and may be spreading. Where invasive species become dominant, they crowd out native plant species and may make the areas unusable by wildlife by eliminating native plant sources of food or shelter.

The natural ecosystems of the Spring Creek Valley are also degraded by the presence of roads along the creek and extending from the uplands down into the valley at several points. Roads are ecologically detrimental for a number of reasons: they fragment forests; they impede wildlife movement; they act as corridors for the introduction and spread of invasive species; they introduce the possibility of accidental spills, and they require earth disturbance and re-contouring that often results in erosion (Forman & Alexander 1998; Trombulak & Frissell 2000; Watkins et al. 2003; Schmidt 1998; Parendes & Jones 2000; Oxley et al. 1974). Roads along a streambank are particularly harmful because any pollution from erosion, road maintenance, or spills is directly inputted into the stream, because the natural processes of stream bank and channel movement often must be artificially stabilized, and because riparian habitat area is lost.

The construction of I-99 directly upland along the eastern edge of the Spring Creek Biological Diversity Area has damaged the ecological health of the area by permanently severing all connection with natural areas to the east of the highway, and imposing a major source of water and noise pollution. The highway construction also paved the southeastern corner of the Biological Diversity Area.

The Spring Creek Valley is a truly exceptional ecological resource because of its diversity and uniqueness, and in comparison to other remaining communities of its type, it is extensive in size and in good ecological health. However, it also faces serious threats to its future viability. At this juncture in determining the future use of land in the valley, the opportunity exists to plan to redress these threats and help to safeguard this resource for future generations. Given the continuing development of the State College-Bellefonte area it is imperative that planners and decision-makers act with regard to the future viability of Spring Creek and its surrounding landscape by thinking 50-100 years into the future.

Results

I.) NATURAL COMMUNITY TYPING.

Thirty different natural community types were found in the Spring Creek Valley. Figure 2 maps their locations. Twelve types were mature natural types; of these, seven are unusual enough in Pennsylvania to be considered of special concern (see Table 1: communities ranked S1, S2, or S3 are of special concern.)

Natural communities were classified following Terrestrial & Palustrine Plant Communities of Pennsylvania (Fike 1999).

********** see next page for Table 1.**********

Table 1. Natural Community Types of Spring Creek Valley

Community Type	# Found	Cultural Type	Natural Type		State Rank
			early-successional	mature	
agriculture	8				
agriculture/cemetery	1				
calcareous cliff/opening	12				S2
disturbed forest	3				
disturbed forest/invasives	1				
dry oak-mixed hardwood forest	10				S3
dry red oak-mixed hardwood forest *	1				S3
floodplain	1				S5
floodplain woodland & meadow	3				S5
green ash-mixed hardwood forest	3				S2
hemlock (white pine) forest	5				S4
larch plantation	2				
low density development	4				
norway spruce plantation	2				
orchard	1				
parking lot	1				
pasture	1				
pine plantation	7				
pine plantation/young regrowth	1				
red oak-mixed hardwood forest	1				S5
rich dry oak-white pine forest*	1				S2
rich hemlock-mesic hardwood forest	3				S2S3
rich hemlock/white pine-mesic hardwoods forest *	1				S2S3
shrub	1				
2nd growth sugar maple-basswood forest*	4				
sugar maple-basswood forest	18				S4
sumac & meadow	1				
sumac clearing	1				
young regrowth	1				
young walnut/invasive shrub	1				
young walnut/pine/invasive shrub	4				

* denotes a community type not found in Fike 1999 classification. Either a variant of an existing type, or a new type not yet classified.

Explanation of Variant/New Community Types

Dry red oak – mixed hardwood forest: This type is a variation of the dry oak-mixed hardwood forest type, with more red oak in the canopy.

Rich dry oak – white pine forest: this is an unusual forest type that includes a combination of species typical in a dry oak - heath forest community, as well as those of a calcareous forest community. Chestnut oak (*Quercus montana* – typical of dry acidic sites), white pine (*Pinus strobus*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and yellow oak (*Quercus muhlenbergi i-* typical of dry calcareous sites) are all canopy dominants.

Rich hemlock/white pine-mesic hardwoods forest: this type is a variant of the rich hemlock-mesic hardwoods forest type. It is distinguished by the presence of white pine as a co-dominant species in the canopy.

Natural Community Types of Special Concern:

Calcareous cliff / Opening: This community type includes herbaceous openings on calcareous soil and cliffs of calcareous rock (limestone, dolomite). There is a specialized assemblage of plant species that live in these habitats exclusively. The habitat is considered of special concern because it is naturally rare in the landscape, and many occurrences have been degraded. Consequently, many of the species that require this habitat are also rare. The examples of this community type found in Spring Creek Valley are limestone cliffs. There are shaded, moist cliffs, and of open, dry cliffs; each hosts distinctive species.

Dry oak – mixed hardwood forest: This forest type occurs on less acidic to somewhat calcareous, moderately dry soils. It is considered of special concern in Pennsylvania because few good examples remain, due to the disproportionate conversion of calcareous soils for agriculture or development. This is the predominant upland forest community in the Spring Creek Valley; its condition ranges from relatively young with fairly high invasive species cover, to more mature and diverse examples. Red oak (*Quercus rubra*), white oak (*Quercus alba*), and hickory species (*Carya glabra, Carya cordiformis*) are dominant in the canopy, while flowering dogwood (*Cornus florida*), alternate-leaved dogwood (*Cornis alternifolia*), and cherry leaf viburnum (*Viburnum prunifolium*) are subcanopy/tall shrub dominants, and the herb layer dominants are nakedflower tick-trefoil (*Desmodium nudiflorum*), Christmas fern (*Polystichum acrostichoides*), and Virginia creeper (*Parthenocissus quinquefolia*). Also common are: Ebony spleenwort (*Asplenium platyneuron*), sticky tick-clover (*Desmodium glutinosum*), sassifrass seedlings (*Sassifrass albidum*), and hay-scented fern (*Dennstaedtia punctilobula*).

Dry red oak – mixed hardwood forest: this type is intermediate between the red oak – mixed hardwood forest type and the dry oak – mixed hardwood forest type.

Green ash – mixed hardwood forest: this community is a forest type that occurs in floodplains of mid-sized streams. Because most floodplains have been ecologically degraded or experienced land use conversion resulting in the removal of natural communities, many floodplain forest community types are now scarce habitats in Pennsylvania, and considered of special concern. In Spring Creek Valley, the steep topography leaves few areas that would host a floodplain forest. The small area of green ash – mixed hardwood forest is one of the few examples of intact floodplain forest in the valley. Other potential floodplain forest sites are in early successional stages or are dominated by invasive species.

Rich dry oak - white pine forest: this is an unusual community that has not yet been described in the Fike 1999 classification. It occurs on a single steep hillside that hosts a diverse mix of species typical of dry acidic soils, and of species typical of dry calcareous soils. It is also exceptionally free of invasive species.

Rich hemlock - mesic hardwood forest: this forest type resembles a species-rich type that is common further south. Although once common in southern Pennsylvania, land use conversion and timbering have removed much of this forest type and few examples remain. The calcareous soils of the Spring Creek valley create favorable conditions for a great diversity of plant species, including many common in more hospitable climatic conditions further south.

Rich hemlock/white pine – mesic hardwood forest: this forest type is a variant of the above that includes white pine.

II.) SPECIAL CONCERN SPECIES & THEIR HABITATS

The Pennsylvania Natural Diversity Inventory (PNDI) contains records for eleven species of special concern living within the Spring Creek Valley. Nine of these species have been documented to live in the valley within the last 10 years. They include three butterfly species of special concern, and six plant species of special concern. During this study one new species of special concern was documented at several locations in the valley, the threeflower melicgrass (*Melica nitens*); and one new population of the round-leaved serviceberry (*Amelancheir sanguinea*) was located.

Table 2. Species of Special Concern in Spring Creek Valley

Common Name	Scientific Name	Global Rank	Date last observed	State Rank	Historic	Current
Low juneberry*	*Amelanchier humilis*	G5	1997-05-15	S1		
Roundleaf serviceberry	*Amelanchier sanguinea*	G5	1997-06-17	S1		
Butterfly species #1 +		G3G4	2001-07-11	S1S2		
Butterfly species #2		G4	1986-07-26	S1S3		
Butterfly species #3		G5	1987-08-25	S2		
Ebony sedge	*Carex eburnea*	G5	1994-11-14	S1		
Geyer's sedge	*Carex geyeri*	G5	1985------	S1		
Laurentian bladder fern	*Cystopteris laurentiana*	G3	1997-05-15	S1		
Threeflower melicgrass	*Melica nitens*	G5	2006-09	S2		
Early buttercup	*Ranunculus fascicularis*	G5	1973------	S1S2		
Lanceolate buckthorn	*Rhamnus lanceolata*	G5	1997-05-15	S1		

*records of this species are likely mistaken identifications of the roundleaf serviceberry
+butterfly species names have been withheld due to the species' sensitivity to collection. Please contact the Pennsylvania Natural Heritage Program for more information.

The state ranks listed above in Table 2 indicate the rarity of the species in Pennsylvania, and the global ranks indicate the rarity of the species in the world. Several of the species ranked "S1" are found nowhere else in Pennsylvania except Spring Creek, or have fewer than five other locations in the state. Where two ranks are listed for a species, not enough data is available to assign a precise rank, so a range is indicated.

This study also included a non-quantitative inventory of populations of the host plants for the butterfly species of special concern. For each of these species, the caterpillar stage feeds exclusively

on a single plant species. The host plants are round-leaved ragwort (*Packera obovata*), prickly ash (*Zanthoxylem americanum*), and wild columbine (*Aquilegia canadensis*). Figures 8-10 map the distribution of each host plant species. Maps created for this study are based on visuals estimates and do not represent quantitative, complete surveys.

Sensitive Habitat Areas Map (Figure 3):

The habitats occupied by the species of special concern, special concern natural communities that are sensitive to disturbance, and the areas occupied by host plant populations which included a substantial number of individuals and occurred within a relatively mature natural community, were combined together to create a map of Sensitive Habitat Areas (figure 3). Exact locations for individual species' populations are not published due to the potential threat of poaching. Please contact the Pennsylvania Natural Heritage Program if further information is required.

III.) EVALUATION OF RIPARIAN AREAS

Most riparian areas have roads present. The few roadless areas are of particular conservation value. The roads along the riparian areas currently are lined with invasive species in most areas. Most riparian areas have moderate to abundant densities of invasive species present. Three invasive plant species, purple loosestrife (*Lythrum salicaria*), reed canarygrass (*Phalaris arundinacea*), and black alder (*Alnus glutinosa*), are wetland species that live exclusively in the floodplain areas close to the streambank. They are not dense now, but have a demonstrated capacity to overwhelm native vegetation and should be monitored. Immediate control may prevent later problems from developing. The former fish hatchery is now particularly densely occupied by invasive shrub species, and is likely acting as a seed source for these species' colonization of other areas.

IV.) IDENTIFICATION AND EVALUATION OF UPLAND AND RIPARIAN FOREST CORRIDORS/LINKAGES.

This task was deemed outside the scope of work of this investigation by project liaisons.

V.) IDENTIFICATION OF RESTORATION OPPORTUNITIES

The three restoration opportunities with the greatest potential to realize ecological benefits are: reforestation of non-forest lands adjacent to the Spring Creek Valley forests; invasive species control in heavily dominated areas; and road removal/mitigation. Each of these opportunities are discussed in detail in the Recommendations section.

Figure 4 maps the dominance of invasive species categorically – low, scattered, common, or abundant. Invasive species control should be prioritized for those areas rated "low", and any adjacent areas rated "abundant". (see Invasive Species Control Recommendations for more information).

Figure 5 maps the areas recommended for reforestation.

VI.) THREATS AND STRESSES

Invasive Species

This study included surveys to document invasive plant species in the valley. The data presented here are based on visual estimates, not quantitative surveys. Fourteen species considered potentially invasive to the natural communities of Spring Creek were found in the valley.

Table 3. Invasive Plant Species in Spring Creek Valley

Common Name	Scientific Name	Growth Form	Habitat			
			Streambank & floodplain	Forest	open areas	cliffs
Tree of Heaven	*Ailanthus altissima*	Tree				
Garlic mustard	*Alliaria petiolata*	Herb				
Black alder	*Alnus glutinosa*	Tree				
Japanese barberry	*Berberis thunbergii*	shrub				
Oriental bittersweet	*Celastrus orbiculatus*	woody vine				
Dame's rocket	*Hesperis matronalis*	Herb				
Privet	*Ligustrum vulgare*	Shrub				
Japanese honeysuckle	*Lonicera japonica*	Vine				
Amur honeysuckle	*Lonicera maackii*	Shrub				
Morrow's honeysuckle	*Lonicera morrowii*	Shrub				
Purple Loosestrife	*Lythrum salicaria*	Herb				
Reed canarygrass	*Phalaris arundinacea*	Herb				
Japanese knotweed	*Polygonum cuspidatum*	tall herb				
Multiflora rose	*Rosa multiflora*	Shrub				

Figure 4 maps the overall dominance of invasive species, while figures 11-15 are maps of dominance for individual species considered particularly problematic.

Other threats and stresses – are discussed below in the Recommendations.

Recommendations

1.) ***Conservation Use for Parcel #2.*** This parcel is directly upslope of one of the most sensitive and unique habitats in the valley, a limestone cliff hosting populations of three plants listed as Pennsylvania Endangered. At least two of the special concern butterflies are also believed to inhabitat the cliff and adjacent slopes. Development of the upslope region is likely to adversely affect the ecological health of the cliff in several ways: it may physically destabilize the cliff, and it will diminish the viability of the unique community on the cliff by permanently separating it from other natural habitats. We recommend that the area be devoted to conservation use and native forest restored, in order to enhance the viability of the natural community on the cliff by extending the now very small area of contiguous natural forest/woodland and creating a wide buffer from the ecological stresses created by surrounding land uses. The other important conservation issue is the limited amount of natural forest along the valley. The reforestation of this parcel will help to create a diverse and viable forest ecosystem.

2.) ***Restore forest in upland areas.*** Forest in the Spring Creek Valley is currently mainly confined to a narrow corridor along the steep slopes above the stream. The forested corridor hosts many examples of unique natural communities and species of special concern, as well as a richness of common native species. However, the long-term viability of these ecosystems, and the elements of special concern, is doubtful because of the small size of the natural communities. The small size of the forests is of especial concern because forests require large areas to function correctly, and provide the matrix upon which embedded smaller communities, such as outcrops, depend. The geometry of the forests in the valley – a long, narrow string of patches broken occasionally by roads— is such that a high proportion of the forested area is edge habitat, rather than interior forest habitat. A large body of ecological research suggests that the current size of the valley forests is not sufficient to sustain a viable forest ecosystem over time, and the threat to future viability is greatly exacerbated by the geometry, with the high proportion of edge. Restoration of native forest communities to the upland areas adjacent to the current forested corridor has the potential to greatly increase overall forest diversity and the forest's long-term ecological viability.

- It will create a buffer between the sensitive and unique slope communities and other land uses. This buffer will help prevent the introduction and slow the spread of invasive species, filter runoff, absorb runoff to prevent erosion along the slopes, and protect the slope communities from edge effects.
- Expansion of forest area will enable the valley to potentially support viable populations of more species. Many species require habitat of a certain area to breed successfully, and in order to ensure long-term viability, enough area must be available to support a sufficient number of individuals to make up a genetically diverse population. Therefore, the size of the forested area along and adjacent to the valley should be maximized within the present opportunity. Two types of ecological principles are involved: (1) the viability of each species present, and (2) the viability of ecosystem functions for the forest as a whole.
- The ecosystems of the Spring Creek Valley are highly endangered in their current extent, and invasive species are spreading aggressively. The presence of I-99 to the east of the valley, and the substantial distance between the forests in the valley and other forest ecosystems, exacerbates the threats to long term viability, because it makes replenishment of species that experience declines or extinctions of their populations unlikely. Reforestation to expand the extent and contiguity of the valley forests is the best hope to develop an ecosystem with the resilience to compensate for these challenges and remain viable into the future. Figure 5 outlines recommended restoration areas. The forest size achieved if the full extent of these

recommendations is undertaken would be near the lower end of what current ecological research deems necessary for long term viability, especially given the isolation of the valley from other forests.

- Some privately held lots adjacent to the valley are also recommended as potential reforestation areas due to the benefits that would incur from expanding narrow sections of forest. In these areas, we recommend exploring landowner amenability to management partnerships with public agencies working elsewhere in the valley.
- All drainage-ways and Spring Creek tributaries should be prioritized for reforestation. Forest cover is the best protection for streambanks, riparian zones, floodplains and slopes. This recommendation includes intermittent tributaries, especially those adjacent to developed landuse. Where possible, develop partnerships to increase forest cover along watercourses leading onto the study property from adjacent lands. The conservation targets are both water quality and riparian vegetation.
- If restoration in the full extent of the recommended areas is not immediately possible, the following guidelines can be used to prioritize restoration areas for maximum ecological benefit: (see figure 6 for illustrations)
    i. Decreasing the proportion of edge habitat will increase the amount of interior forest habitat available, and help to slow the spread of invasive species. Plan restoration areas to widen narrow segments of forest, and to create a smoother outside edge with non-forest land uses that maximizes interior area.
    ii. Increased forest connectivity enhances ecological viability by making a larger area of contiguous habitat available to forest inhabitants. Work to restore forest in gaps between forest segments.
    iii. To maximize forest viability, when developing long-term plans for land use utilize the areas furthest from the valley first for non-forest landuses, and minimize the edge created. For example, if agricultural fields or other disturbance types are necessary, plan these to occupy a strip adjacent to I-99.

3.) ***Restore conifer plantations to native forest communities.*** If forest management plans are developed for the valley, these may include encouraging regrowth of native forest communities in areas currently occupied by conifer plantations. As these areas will likely revert naturally in a matter of decades, upland reforestation is considered a greater priority. See figure 7, map of pine plantation areas.

4.) ***Reduce road miles wherever possible.*** Road can act as vectors for invasive species colonization, fragment and reduce the area of natural habitats, can result in erosion of streambanks and slopes, and can be the source of pollution spills, etc.. Roads also require maintenance that can damage habitats, e.g. quarrying fill from the base of valley slopes has taken place in past times with damaging results. Restoration of roads to forest or natural floodplain communities will mitigate these problems and enhance ecological health. Some roads could be transformed into trails, with only emergency access by vehicles.

5.) ***Apply Best Management Practices to all existing roads and parking areas.***

- Minimize road width to what is essential to carry traffic.
- Allow native vegetation to extend to edges of road (or parking areas), and allow forest canopy to enclose road wherever possible. Do not mow, spray, or plant non-native species such as crown vetch or brome grass.
- Manage grading of roads and runoff carefully to prevent erosion and stream sedimentation problems.

- Maintain a riparian buffer of natural native vegetation along stream edges.

6.) ***Allow only foot traffic along roads and paths.*** Many of the unique habitats of the corridor are fragile, and motorized vehicles, ATVs, or mountain bikes will destroy them. Vehicular traffic along roads increases erosion, creates noise pollution that disrupts wildlife, and causes roadkills of wildlife (Trombulak & Frissell 2000; Formann & Alexander 1998; Seiler 2001). To minimize all traffic along roads and prevent off-road excursions into sensitive habitat areas, we recommend that the roads in the stream valley be closed to vehicular use for the public, and used for emergency vehicle access only by management agencies.

7.) ***Protect sensitive habitat areas.*** Figure 3 maps the areas which contain special concern species or natural communities that are especially fragile or sensitive to disturbance. It is especially important that buffers of native forest are retained/restored around these areas, and that even foot traffic is directed away from them. Rock climbing is a particular threat to the delicate plant communities of the cliffs, and should be prohibited in all sensitive habitat areas. Educational efforts to communicate the sensitivity of the habitats may be necessary to obtain public compliance with this prohibition.

8.) ***Consider a permitting system for public use of the park.*** Some popular state and national recreation areas have developed permit systems to allow public access to the area while limiting traffic to an ecologically sustainable level.

9.) ***Prohibit pesticides.*** Avoid spraying pesticides or releasing air-borne toxins in the entire valley, as the area is host to butterfly species of special concern. E.g., gypsy moth control, agricultural use, etc.. The most detrimental pesticides are those of a general nature (broad spectrum), when applied broadly across the landscape.

10.) ***Monitor and control invasive species.*** Control measures should be evaluated, with priority on areas where invasives have become overwhelmingly dominant, and high-quality habitats where they are still very sparse. For example, oriental bittersweet (*Celastrus orbiculatus*) has formed dense stands in some pine plantation and young regrowth areas, and this species may be a particular threat due to its potential to form a densely choking mat over forests. Monitor invasive density to determine how rapidly they are spreading and increasing, and evaluate needs for control. See Figure 4 for mapping of invasive density.

11.) ***Monitor special concern species.*** To track the health and extent of populations of plant and animal species of special concern in the valley, a citizen volunteer monitoring program may be developed. Seek assistance from the Pennsylvania Natural Heritage Program, which maintains information on the flora, fauna and natural communities of the valley. Assistance might also be available through biology professors at the Pennsylvania State University, or through the Pennsylvania Native Plant Society, which has many knowledgeable members local to Centre County.

12.) ***Protect groundwater.*** Do not conduct extensive earth-moving or digging in the Spring Creek Watershed without detailed hydrologic studies. Eighty-percent of the flow of Spring Creek is groundwater, and disruption or contamination of groundwater flow into the creek will endanger the stream's ecological health and its status as a world-class trout fishery. Managers of the Spring Creek canyon should work closely with entities working to conserve the entire watershed.

13.) ***Plan carefully for any new water withdrawals.*** In the area occupied by the groundwater aquifers that provide most of the flow of Spring Creek (which includes the surface watershed plus additional areas; see USGS hydrogeologic study 2005), no new wells should be drilled without conducting hydrogeological studies to assess the impact on aquifer flow patterns and total water supply. Proposals for surface water withdrawals should also be assessed to ensure that negative ecological impacts will not result from excessively diminishing water levels in the creek. Maintaining healthy

soil moisture, both in riparian and upland areas, is also a concern relative to the withdrawal of water from aquifers or the creek proper.

14.) ***Manage surface runoff.*** Use extreme caution in managing any stormwater or sewage in the Spring Creek Watershed, to prevent sedimentation or contamination of the stream. A review should also be made of the stormwater runoff from I-99 and the potential influence of this drainage on the quality of Spring Creek and the tributaries within the canyon area.

15.) ***Encourage the control of the white-tailed deer population.*** Signs of mild overbrowsing were visible in some areas, however, assessment of the actual influence of deer herbivory on Spring Creek habitats or plant and animal species is beyond the scope of this study. Managers should understand that an out-of-balance deer population will potentially impact many species of plants and other wildlife, including some wildflowers and low-nesting bird species. Deer hunting in the area will reduce browsing pressure on the plant communities of the corridor.

16.) ***Develop an ecologically-based management plan.*** Stewardship of the ecological health of Spring Creek and its surrounding ecological communities for future generations may best be ensured by the development of an ecological management plan to guide all activities in the valley. Such a plan should identify the resources, determine their needs for long-term health and viability, consider ecological function at a landscape scale, and provide for ecological monitoring of the health of physical and biological resources. A well-devised plan will also take into consideration potential environmental influences emanating from beyond the property, as well as the need to protect adjacent areas that might be ecologically linked to the valley's ecosystems.

Invasive Species Control Recommendations

1.) ***Increase forest contiguity and canopy cover.*** Generally, almost all of the invasive species found in the Spring Creek Valley establish and grow best in higher light conditions of forest gaps, open areas, or forest edges. Therefore, a general recommendation is to work towards increasing the contiguity of forests, such that more forest area is interior rather than edge. Full canopy cover should also be maintained, and developed in areas where the forest is open. This will maximize the area where shaded conditions prevail that favor native species, and where the exotic species do not establish or grow as well.

2.) ***Consider and attempt to minimize the overall ecological impact of control methods.*** There is no use destroying the forest in order to save it from exotic species. Toxic chemicals should be avoided because they are often persistent in the environment and detrimental to many species, and water quality is important to the exceptional fishery in Spring Creek. Where mechanical controls are employed, minimize trampling, soil disturbance, and other disruption to the surrounding plants and environment.

3.) ***Do not attempt invasive species control in sensitive habitat areas without guidance of a knowleadable botanist.***

4.) ***Control Oriental Bittersweet.*** This species is a vine with a very high growth rate, and can overrun a forest in a few years. It not only shades out shrub and herb species, it chokes trees. Therefore its removal is of highest priority. It does not form a persistent seed bank, and establishes best in high-light areas. However, it can also establish under canopy, and persist for many years; when light increases due to treefall or disturbance, the plant then grows rapidly. It requires male and female

plants to produce seeds. Its seeds are dispersed by birds. The program described below for shrub species is also applicable to Oriental Bittersweet.

It is recommended to monitor for this species about two weeks after peak fall foliage. It can be easily detected at this time, because most native deciduous plants have dropped almost all of their leaves, while Oriental bittersweet leaves turn lemon- to golden- yellow, and are thus easily identifiable even from a distance. (Dreyer 2003).

5.) ***Shrub species control:*** For all the shrub species, a two-fold strategy is recommended.

- Remove invaders early. Areas where the species is not well established should be monitored so that young sprouts can be detected and removed. Controlling infestation is most effective, and least labor-intensive or disruptive, if sprouts are removed while they are few, and before they reach reproductive maturity and start raining seeds.
- Control seed sources. In order to slow the spread of these species, it is also important to remove seed sources, so in areas where mature shrubs are established it is recommended to cut them back to the base to prevent seed production. Honeysuckle species should not be cut in winter, as this causes them to re-sprout exceptionally vigorously in the spring. Although cut-back shrubs do re-sprout, repeated cutting will eventually kill them.

6.) ***Tree-of-Heaven control:***

- Hand-pull seedlings before their tap root is established, most optimally after a rain when the soil is loose. If the root system remains the plant will resprout
- Girdle or cut adult trees. Girdling leaves the dead stump standing but is less labor intensive. Individuals will continue to resprout from the roots until their reserves are exhausted, so repeated cuttings may be required. The best time for cutting/girdling is when the plants begin to flower, because their reserves will be lowest. (Hoshovsky 1988)

7.) Garlic mustard control

- This species can spread to form dense stands in the herbaceous layer, outcompeting native plant species almost completely. The mechanism for its success may be its biennial lifecycle- sprouting in the fall, then developing to a rosette next spring, then flowering the following spring. It may also be related to chemicals the plant produces that inhibit growth of other plants. It appears to inhibit mychorrizal growth, which will impact the future success of tree growth. It also acts as a sink for native butterfly species- the females lay eggs on the plant because it resembles native mustard family plants, but the larvae do not survive when they hatch.
- Garlic mustard is extremely difficult to eradicate because it colonizes easily through abundant seed production, and because the seeds are persistent in the seed bank.
- Control should be prioritized in high-quality communities where it is not yet abundant.
- Because seeds can mature to viability if immature stalks are cut, and because plants may resprout to flower multiple times per year, cutting is not effective.
- Recommended practice is to hand-pull plants before seed production, in early spring or late fall. Late fall is preferred because native plants are dormant, while in early spring they will be emerging and the potential exists to damage them through foot traffic. (Nuzzo 2000).

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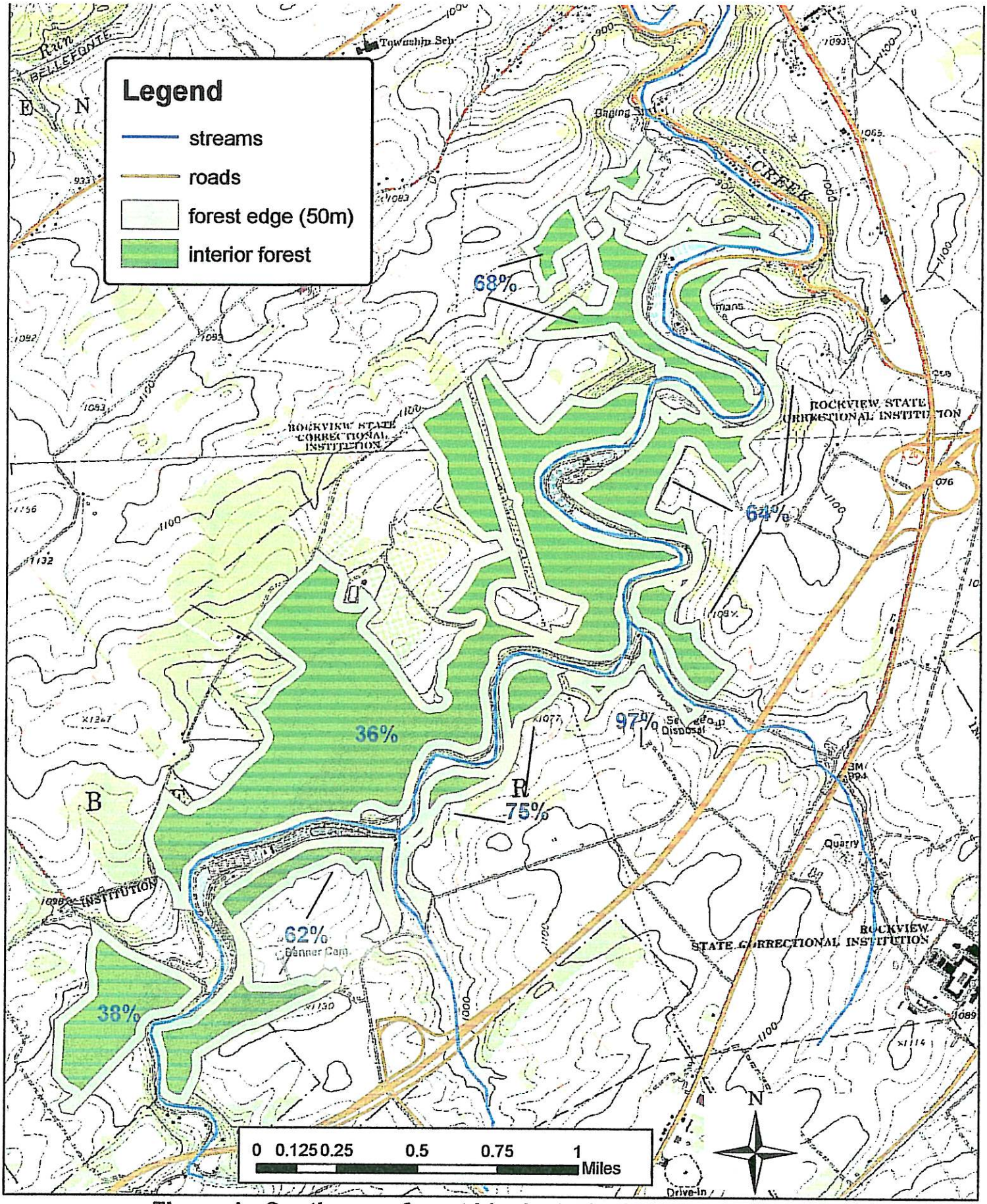


Figure 1. Contiguous forest blocks in Spring Creek Valley with percent edge habitat per block.

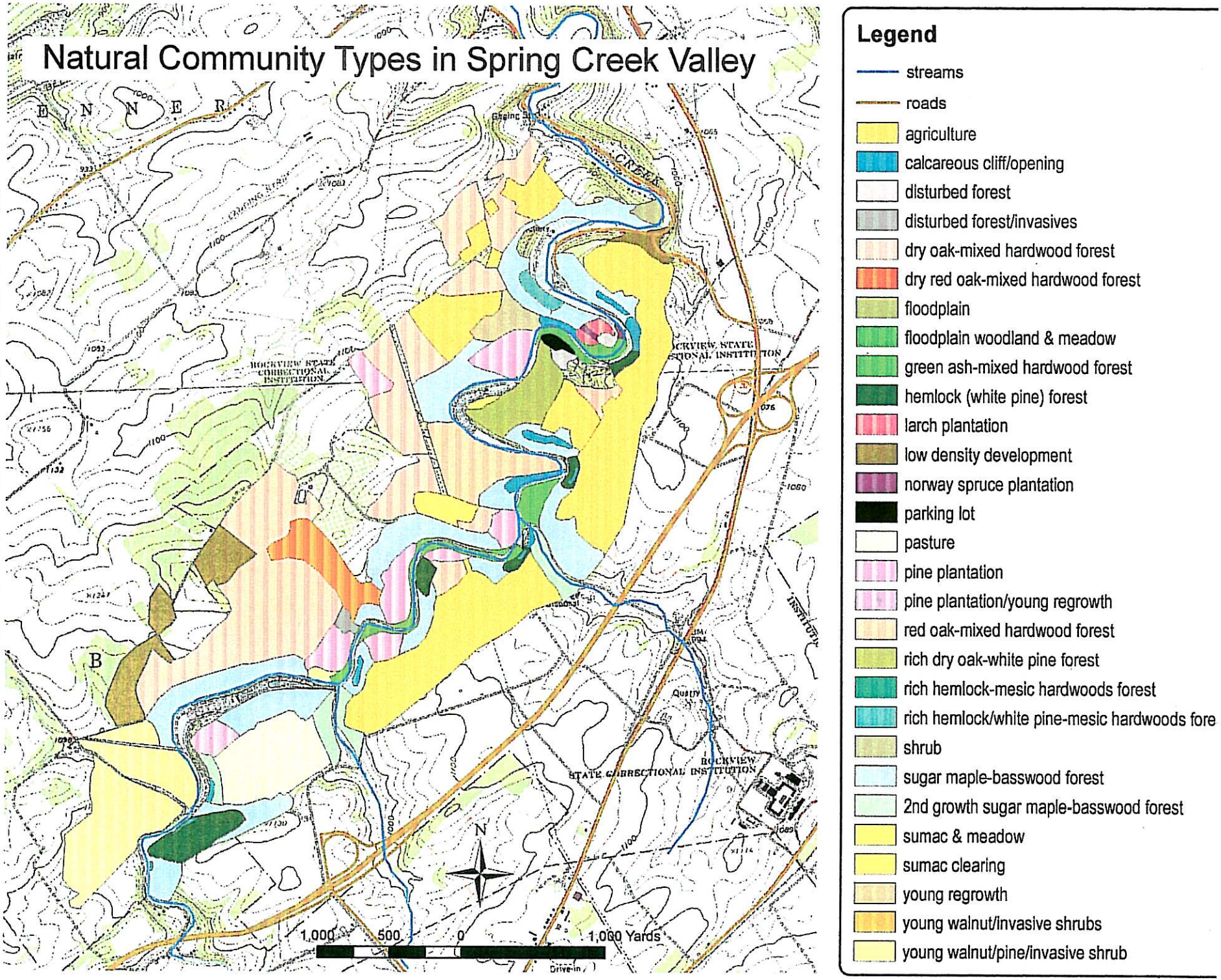


Figure 2. Natural communities of Spring Creek Valley.

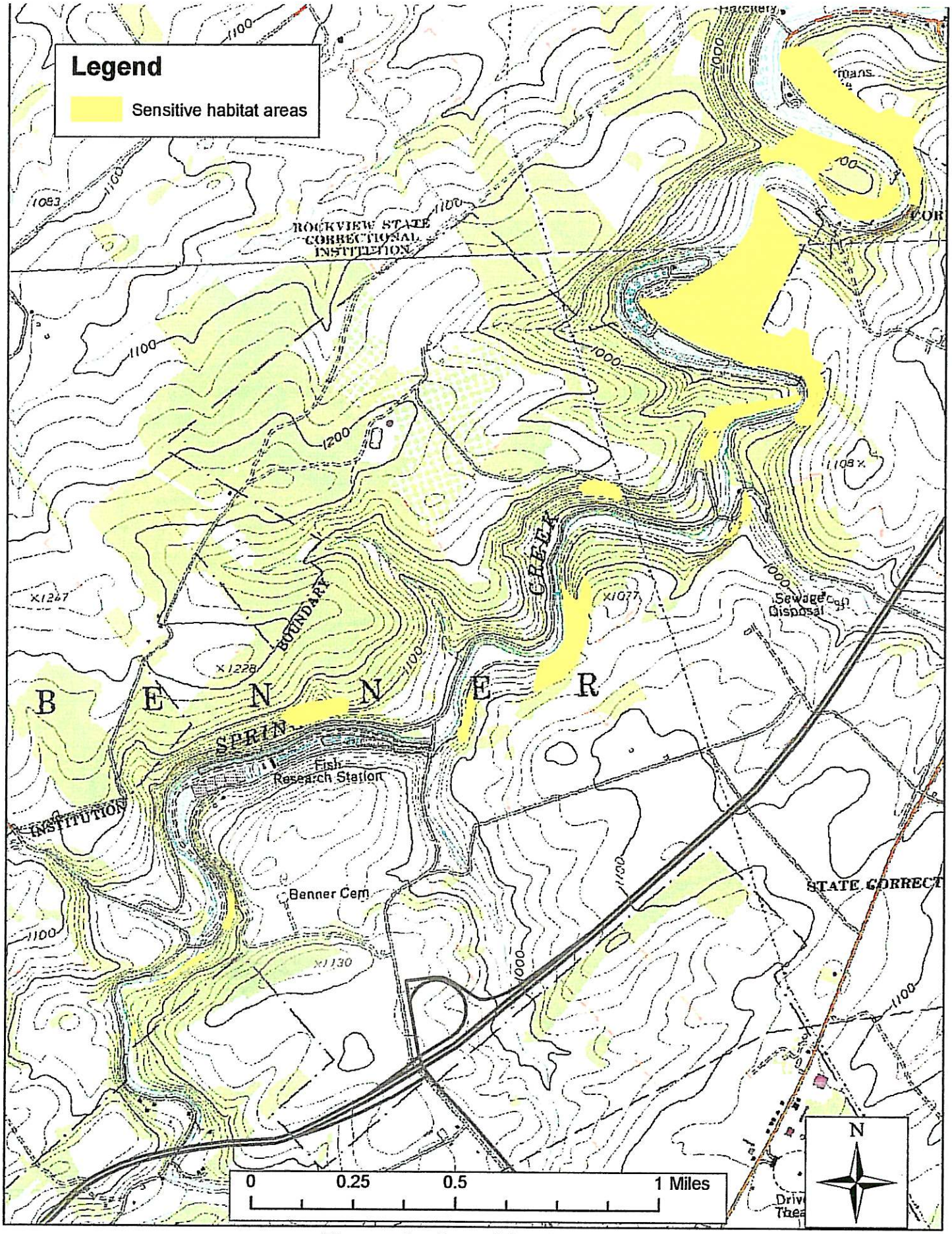


Figure 3. Sensitive Habitat Areas.

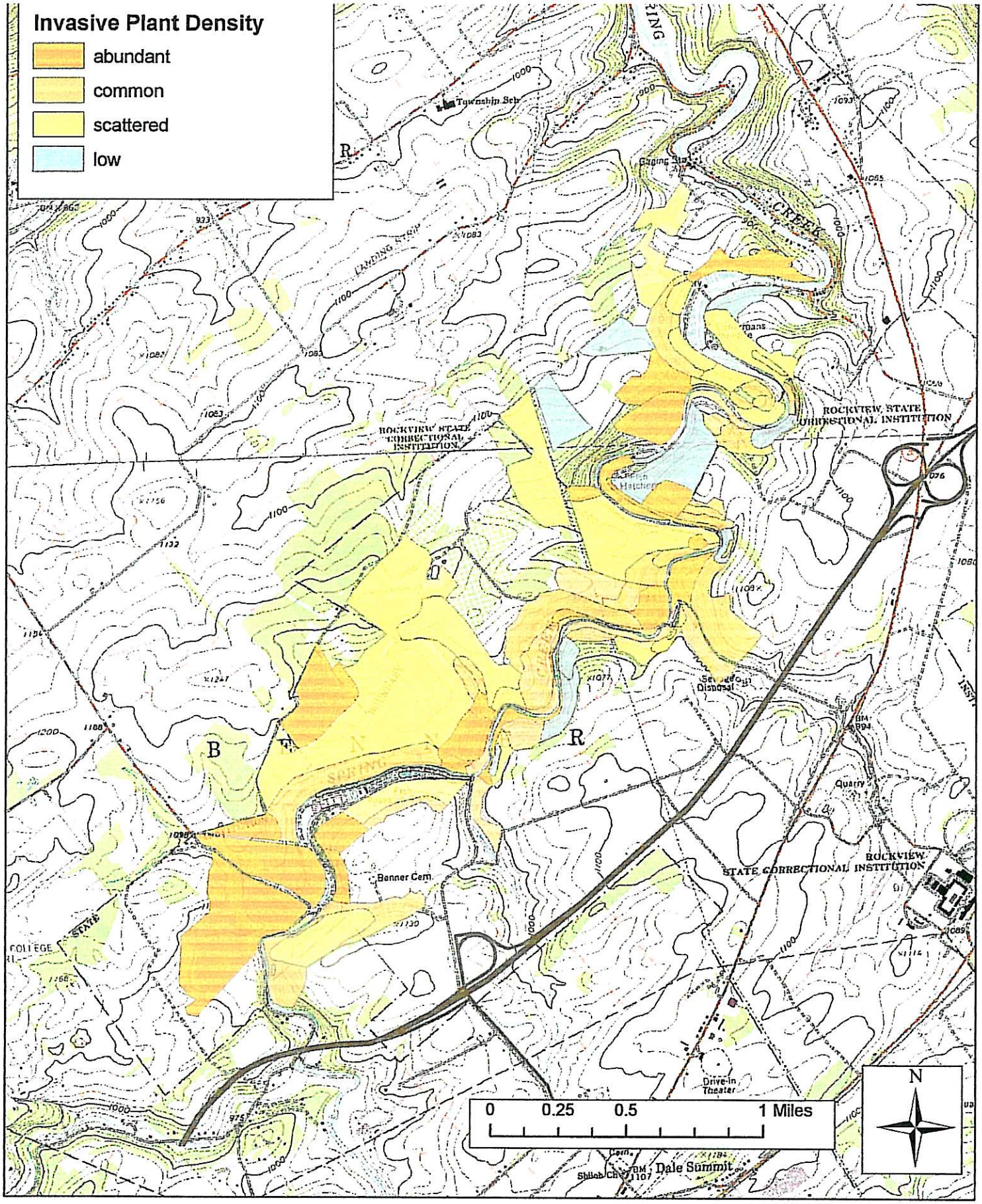


Figure 4. Invasive Plant Density.
Estimated from field survey observations.

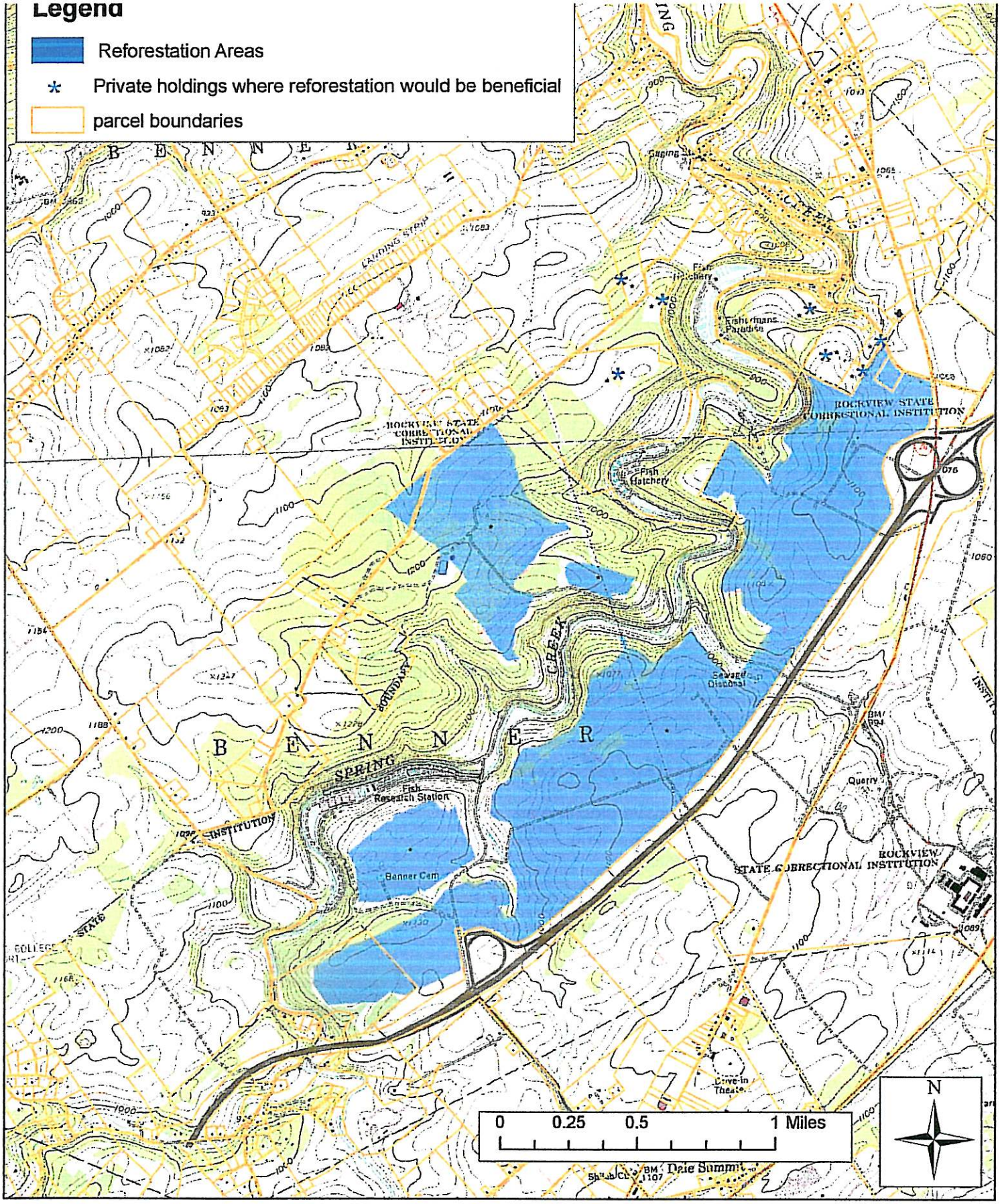
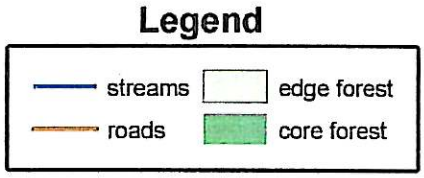


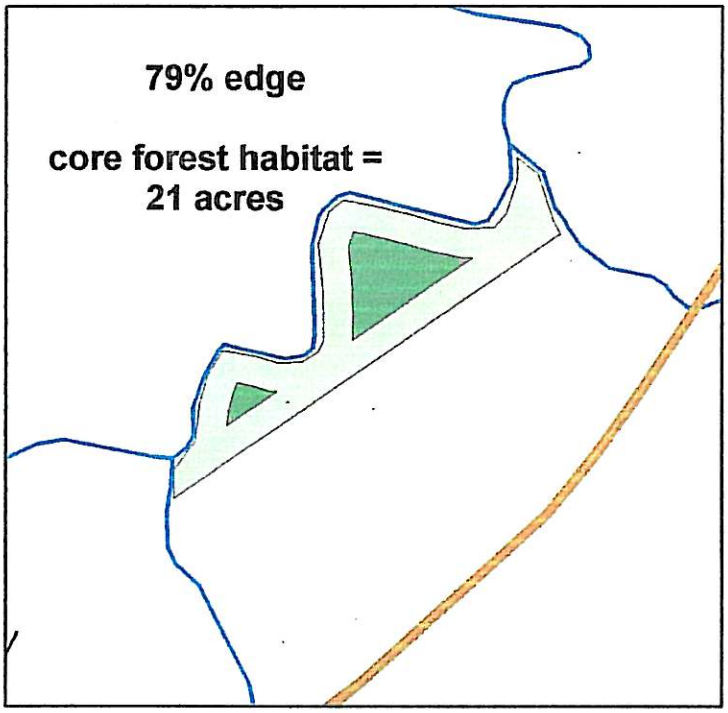
Figure 5. Reforestation Areas.

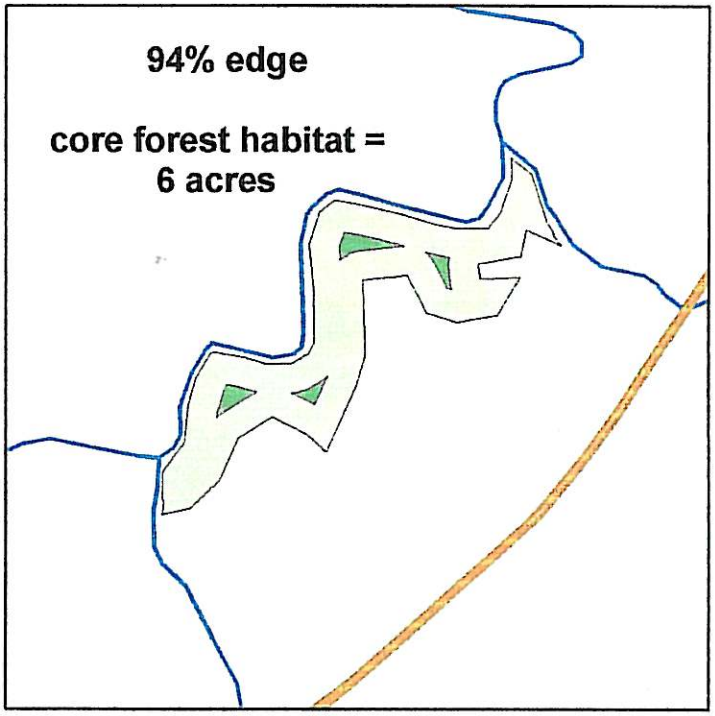
Note: some areas displayed as non-forest on topo map have regenerated forest since publication of map. Reforestation areas were identified from inspection of recent aerial photography.

Reforestation Guidelines Illustrated



I. Smooth boundaries help minimize edge



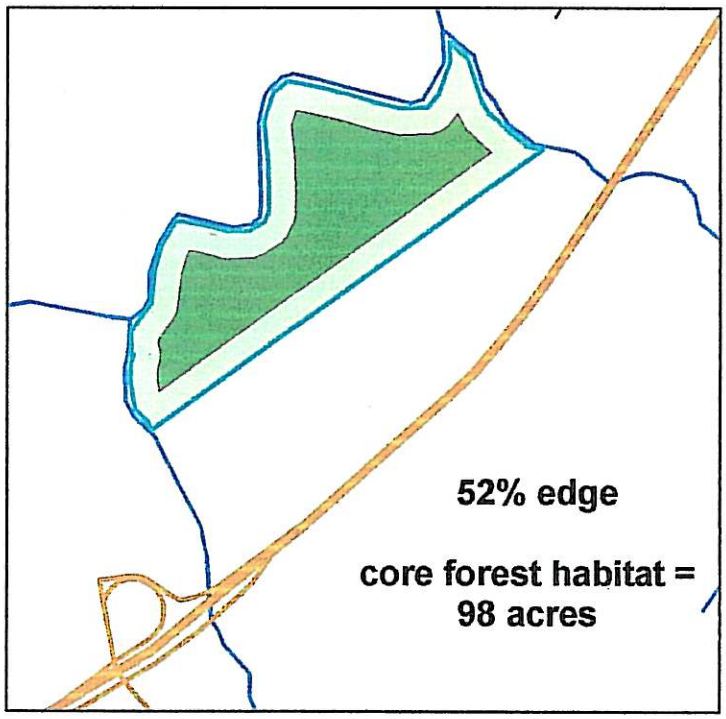


ABOVE: Both forest patches have the same area: however, the patch on the right has much more edge habitat because of its shape. The patch on the left minimizes edge with a straight, not jagged, boundary between forest and non-forest land use.

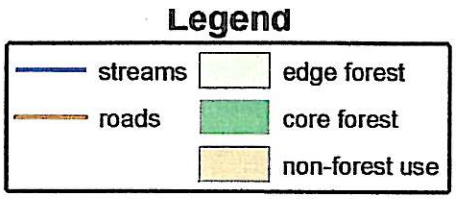
II. Enhance contiguity of core forest habitat

RIGHT: Both forest patches above have pinch points where the patch is so narrow that there is only edge habitat, creating islands of core habitat.

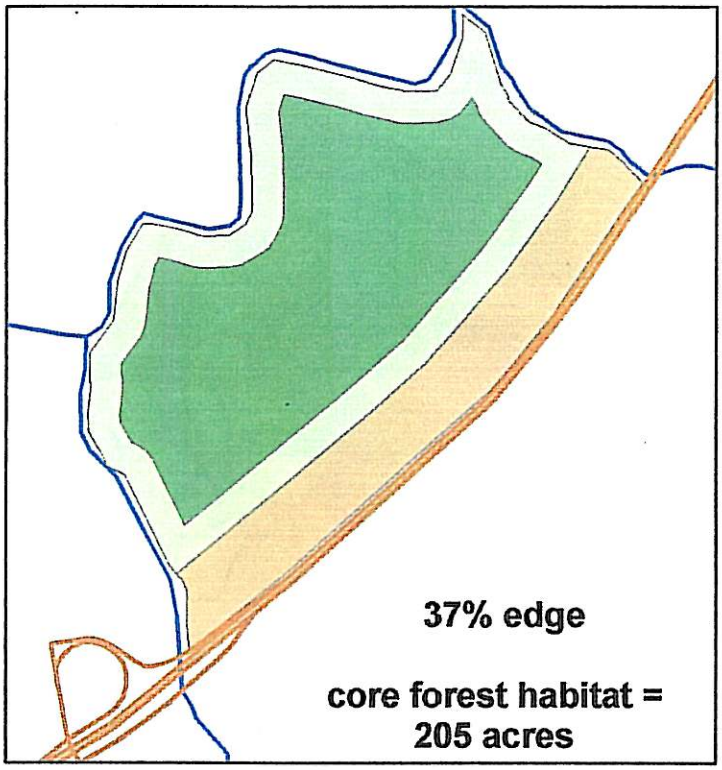
Increasing the width of narrow areas to provide at least 150 m of contiguous core forest habitat will create a larger contiguous forest ecosystem.

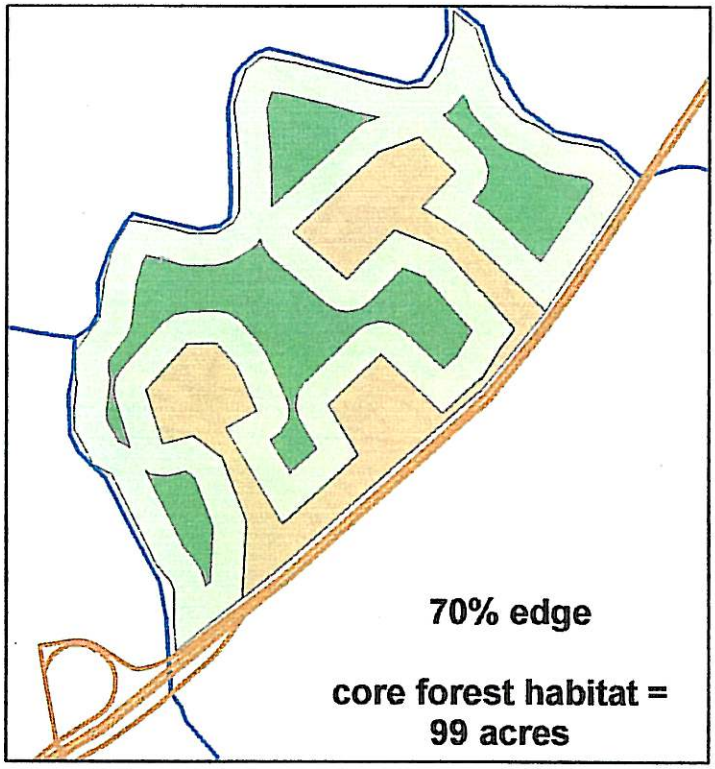


Reforestation Guidelines Illustrated



III. Plan non-forest land use at outer edge of valley

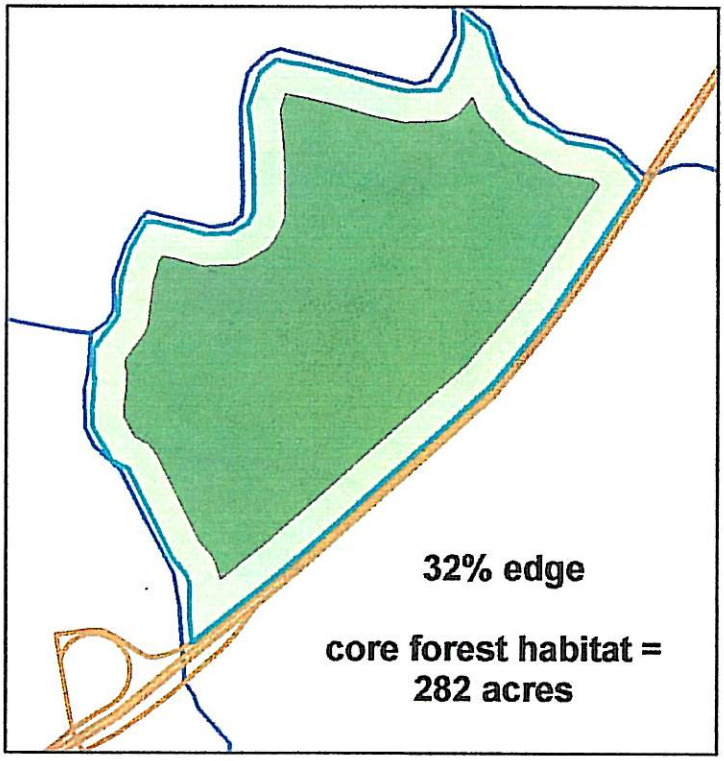




ABOVE: Both plans allocate the same acreage to non-forest use and to forest. However, the plan on the left offers a much more contiguous forest area, illustrating the ecological benefits that can be realized by placing non-forest land uses at the outer edge of the valley with a smooth boundary between land uses.

Ecological viability increase with size

RIGHT: Fully reforested patch maximizes ecological viability. As the size of a forest patch increases, edge habitat occupies a lower percentage of the total area. Observe the differences in the progression of illustrations on the previous page and this page; as the patch sizes are larger, the percent edge habitat decreases dramatically- from 90% edge to 32% edge. The core forest habitat increases from 6 acres to 282 acres.



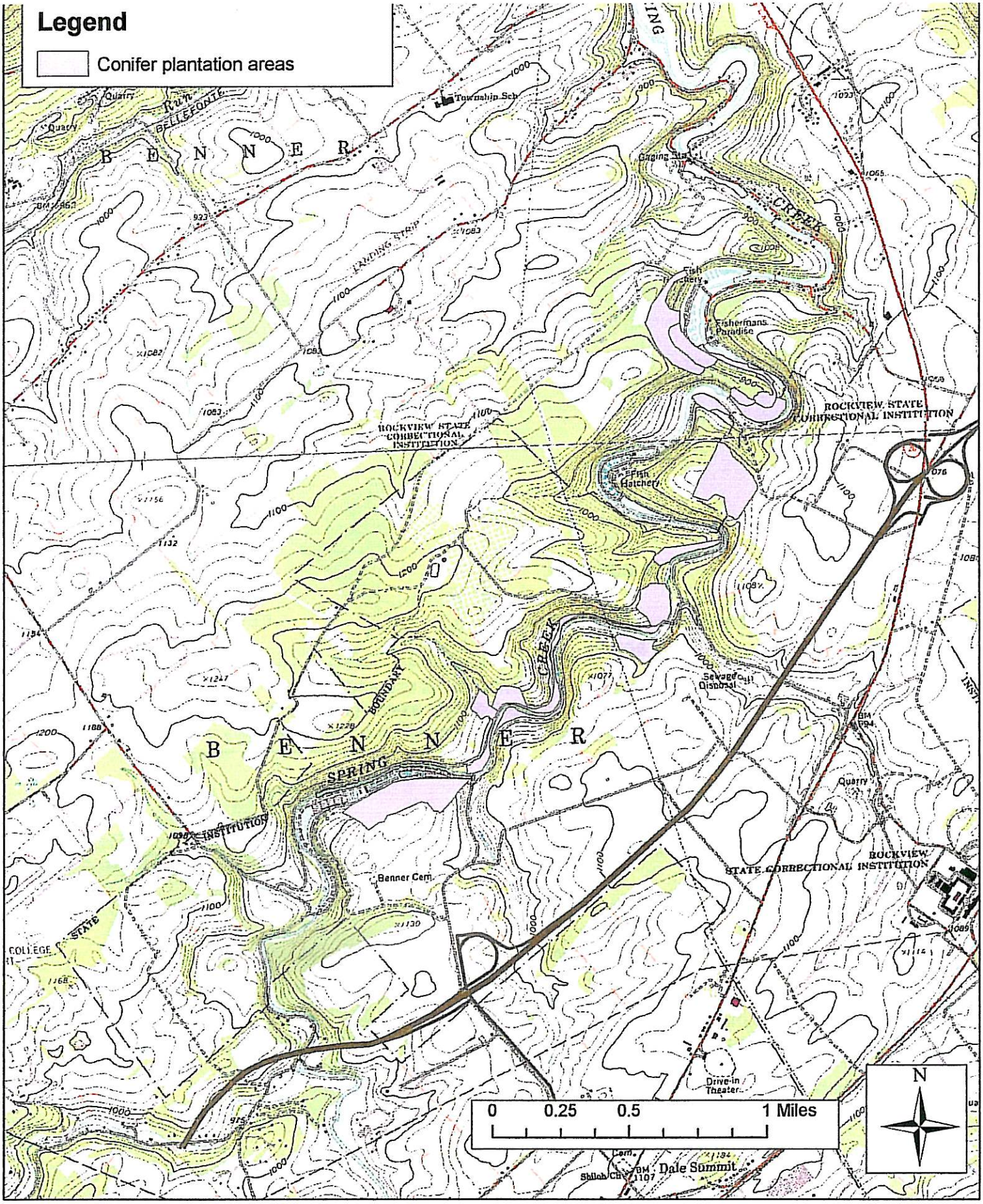


Figure 7. Conifer plantation areas.

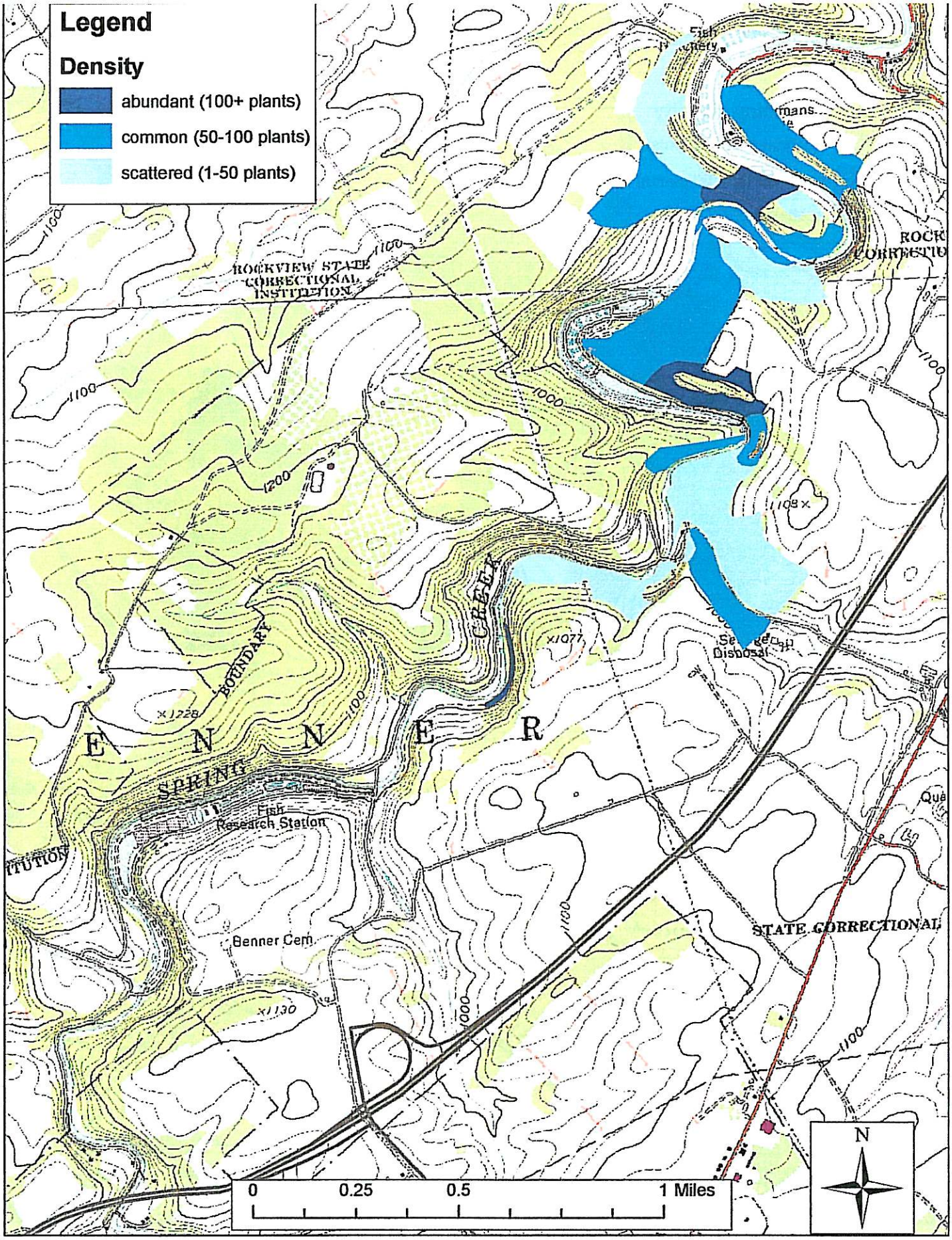


Figure 8. Prickly ash distribution & density.

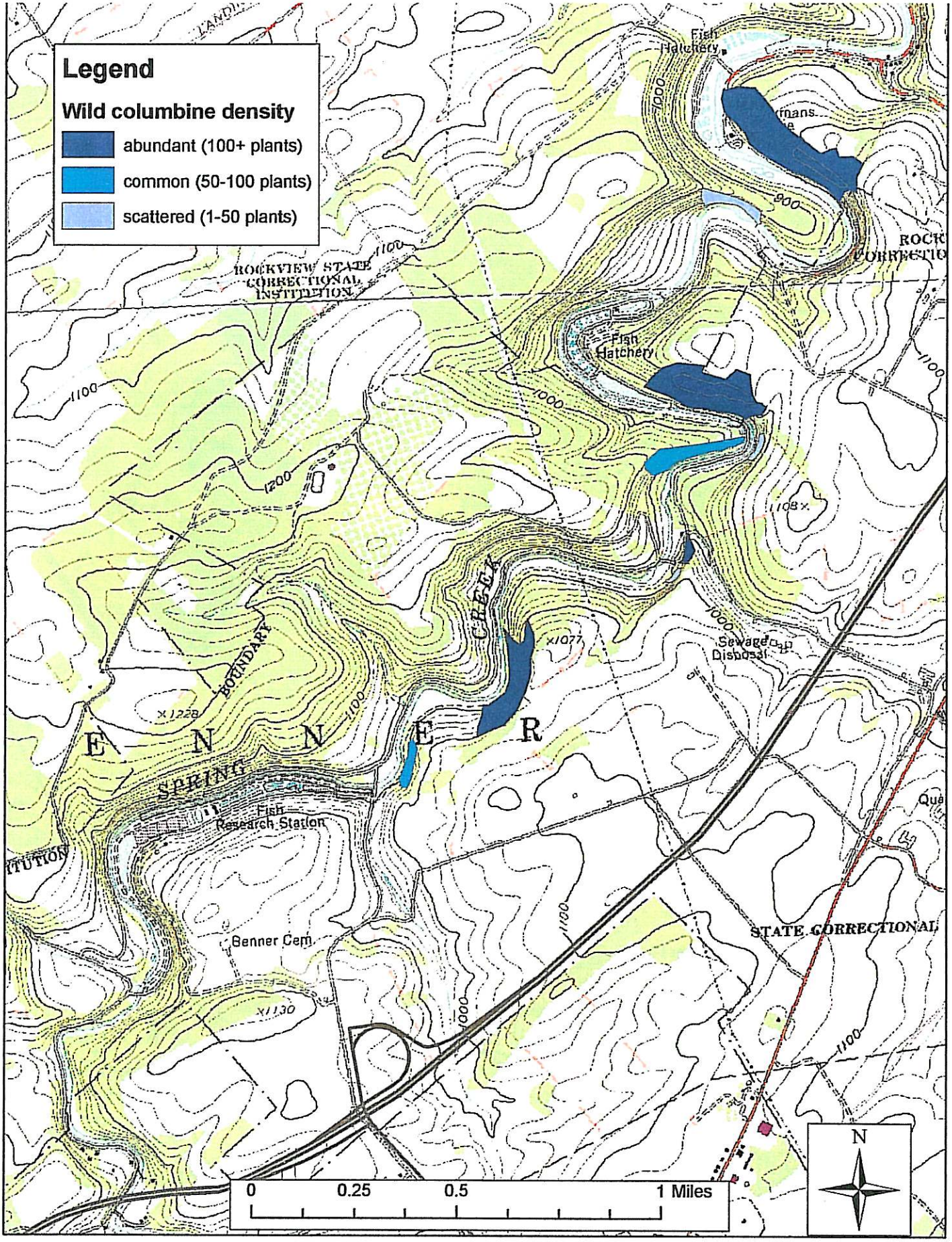


Figure 9. Wild columbine distribution & density.

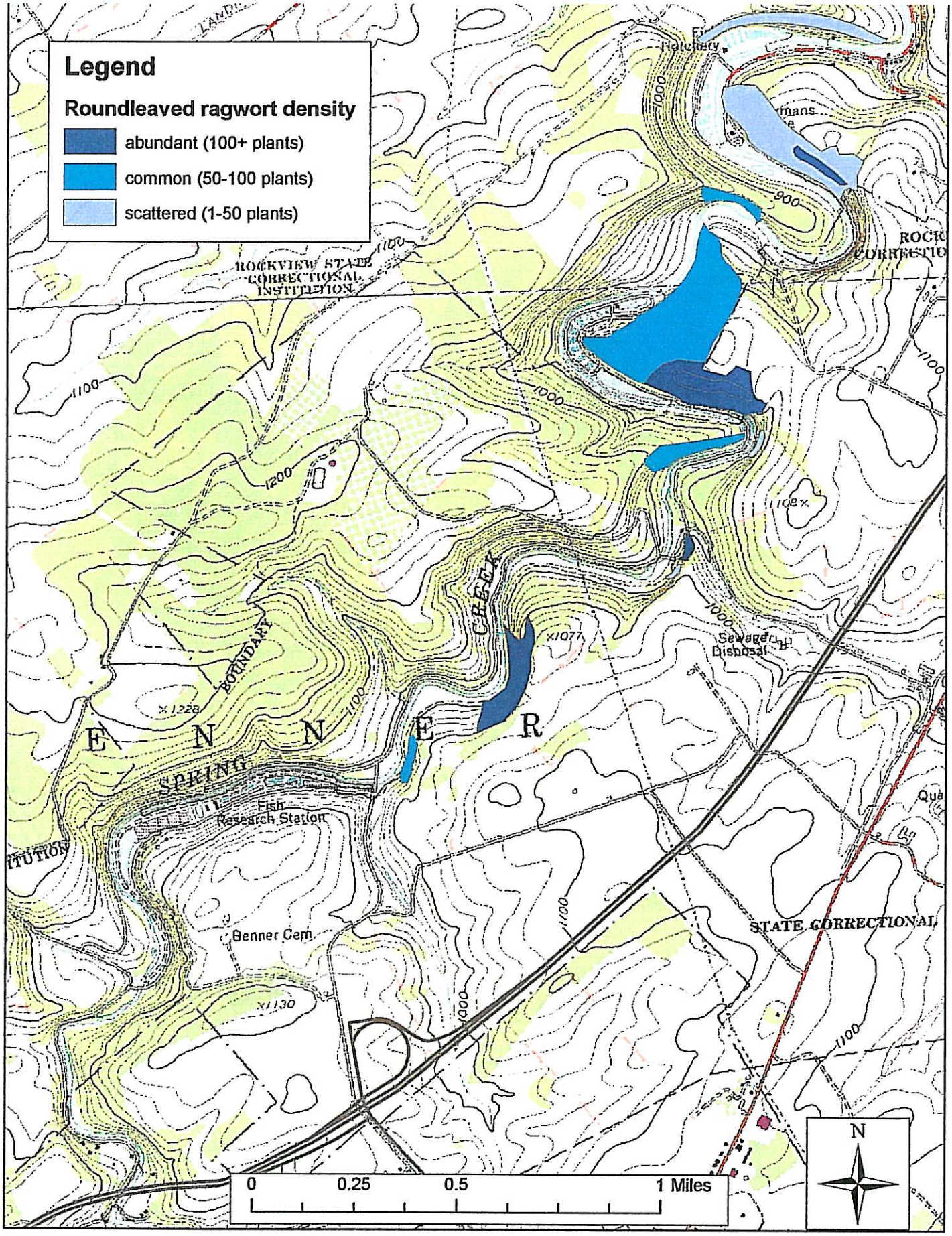


Figure 10. Roundleaved ragwort distribution & density.

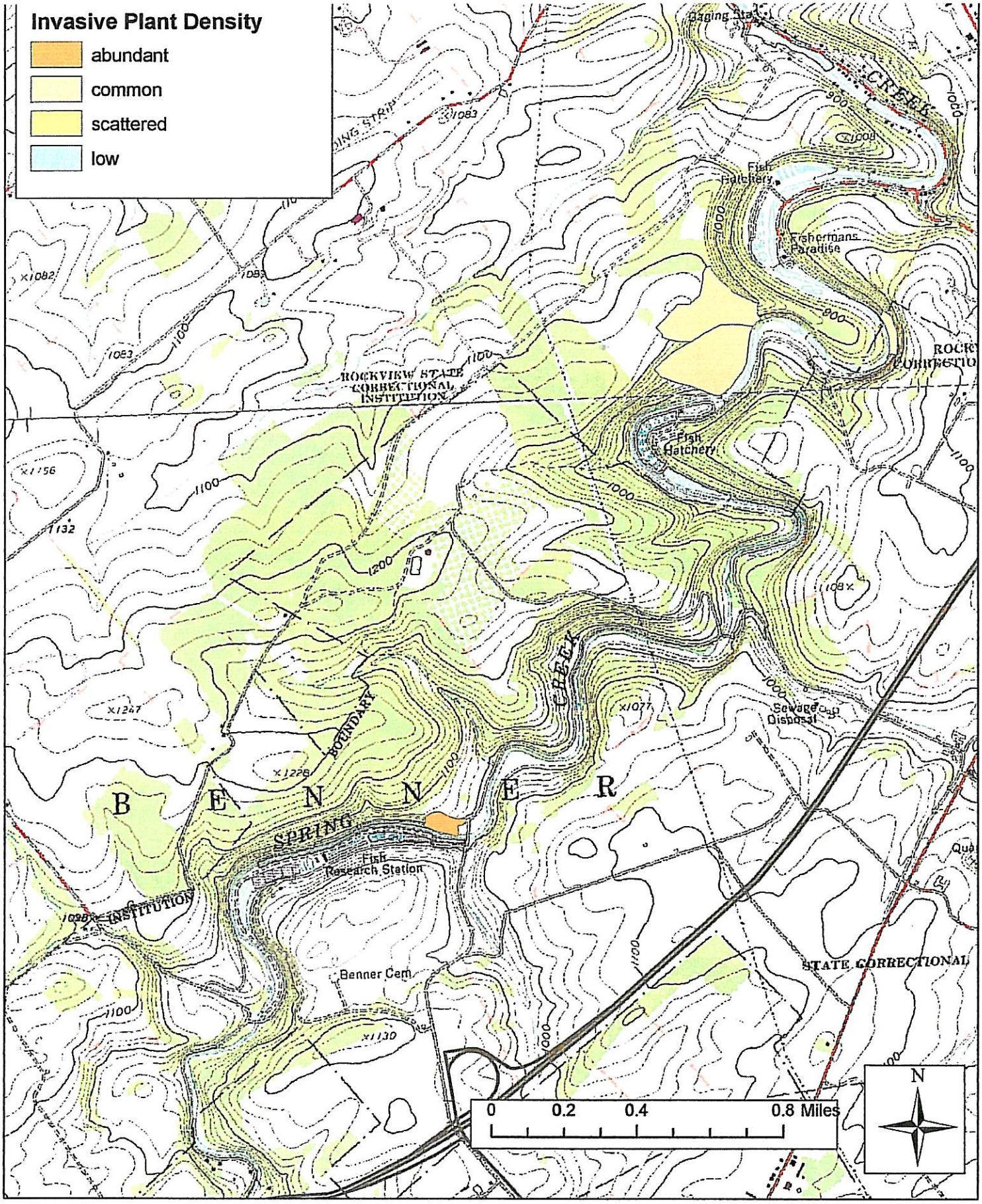


Figure 11. Density & Distribution of Tree of Heaven (Ailanthus altissima).
Estimated from field survey observations.

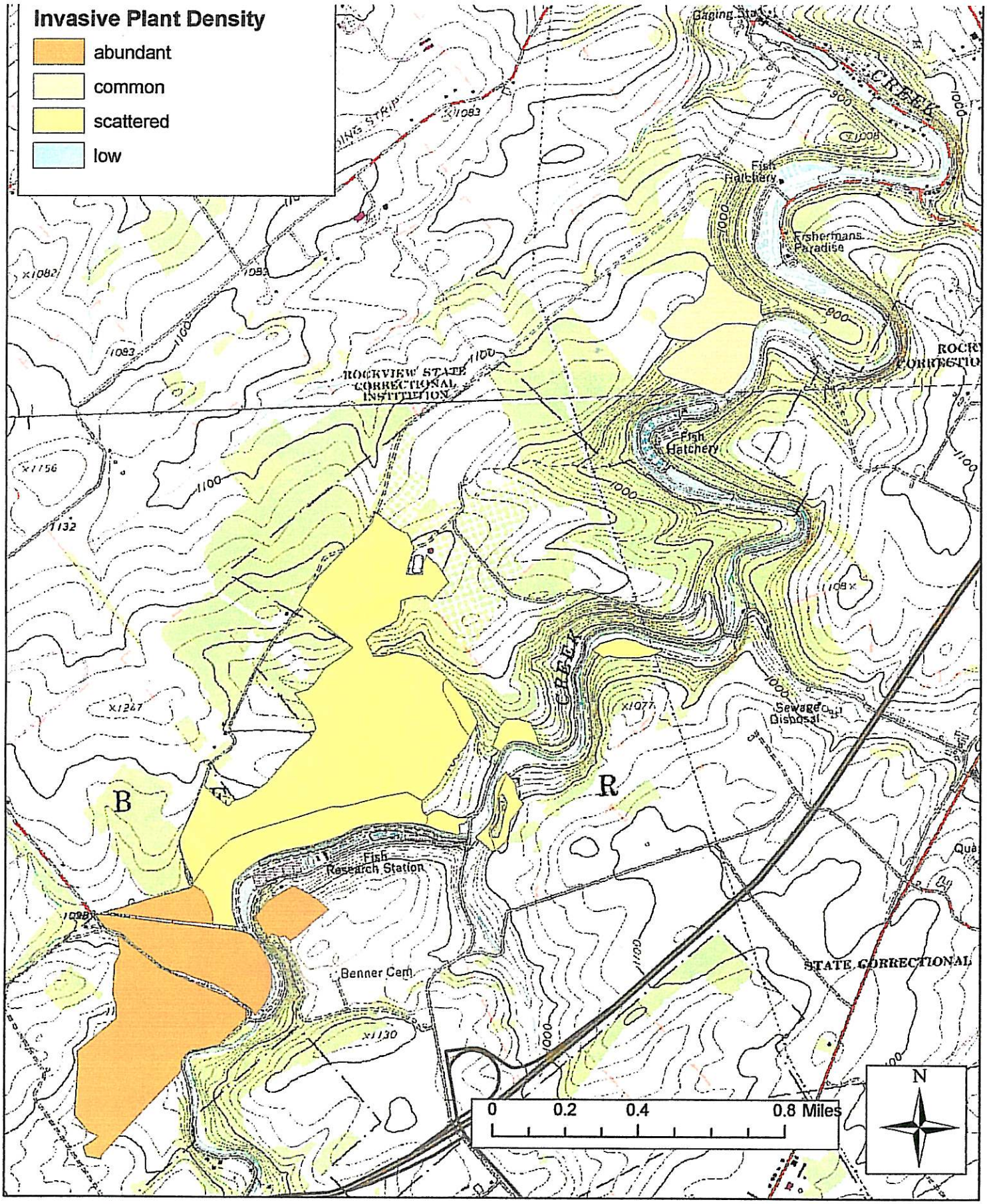


Figure 12. Density & Distribution of Oriental Bittersweet (Celastrus orbiculatus).
Estimated from field survey observations.

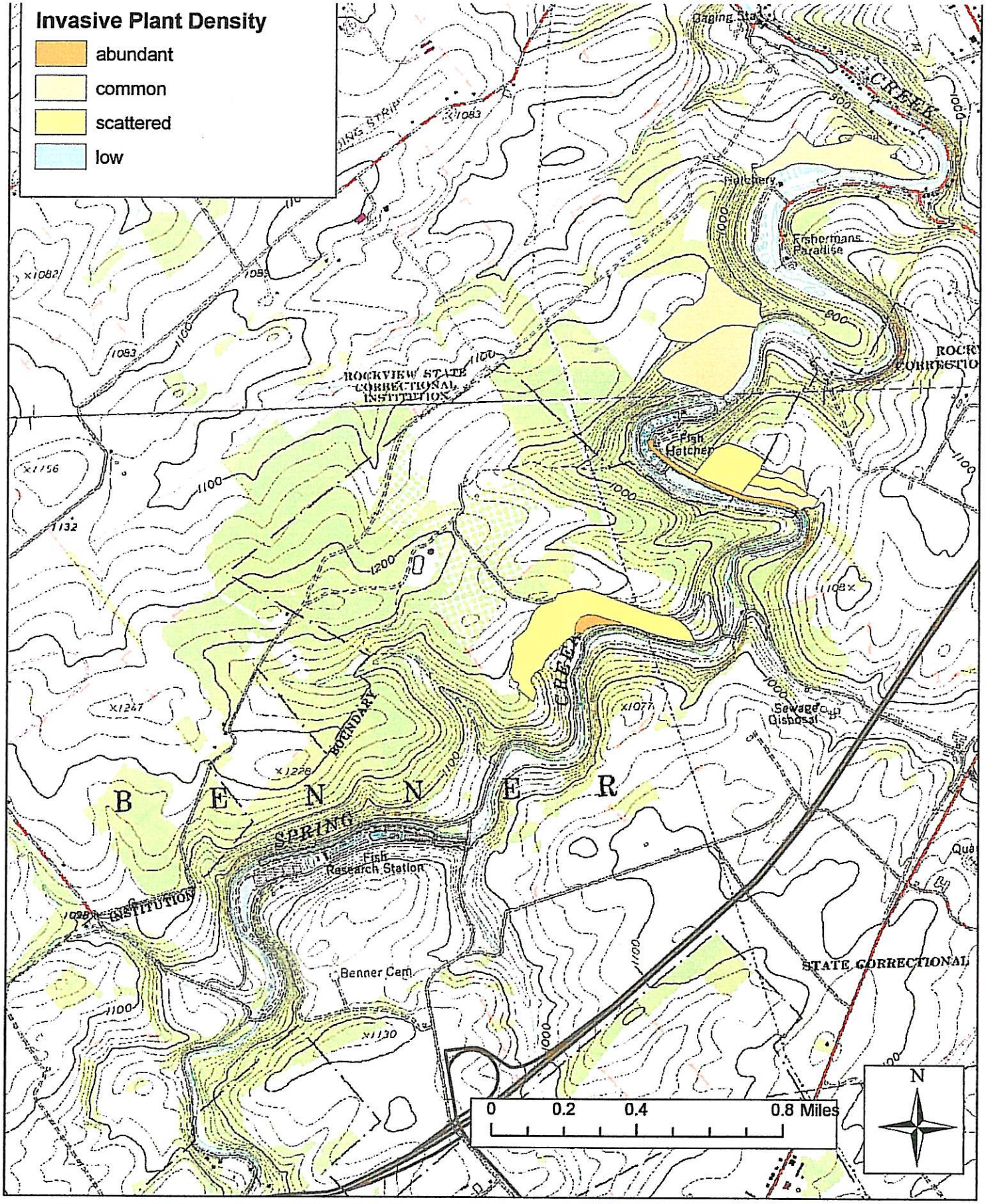


Figure 13. Density & Distribution of Japanese honeysuckle (Lonicera japonica).
Estimated from field survey observations.

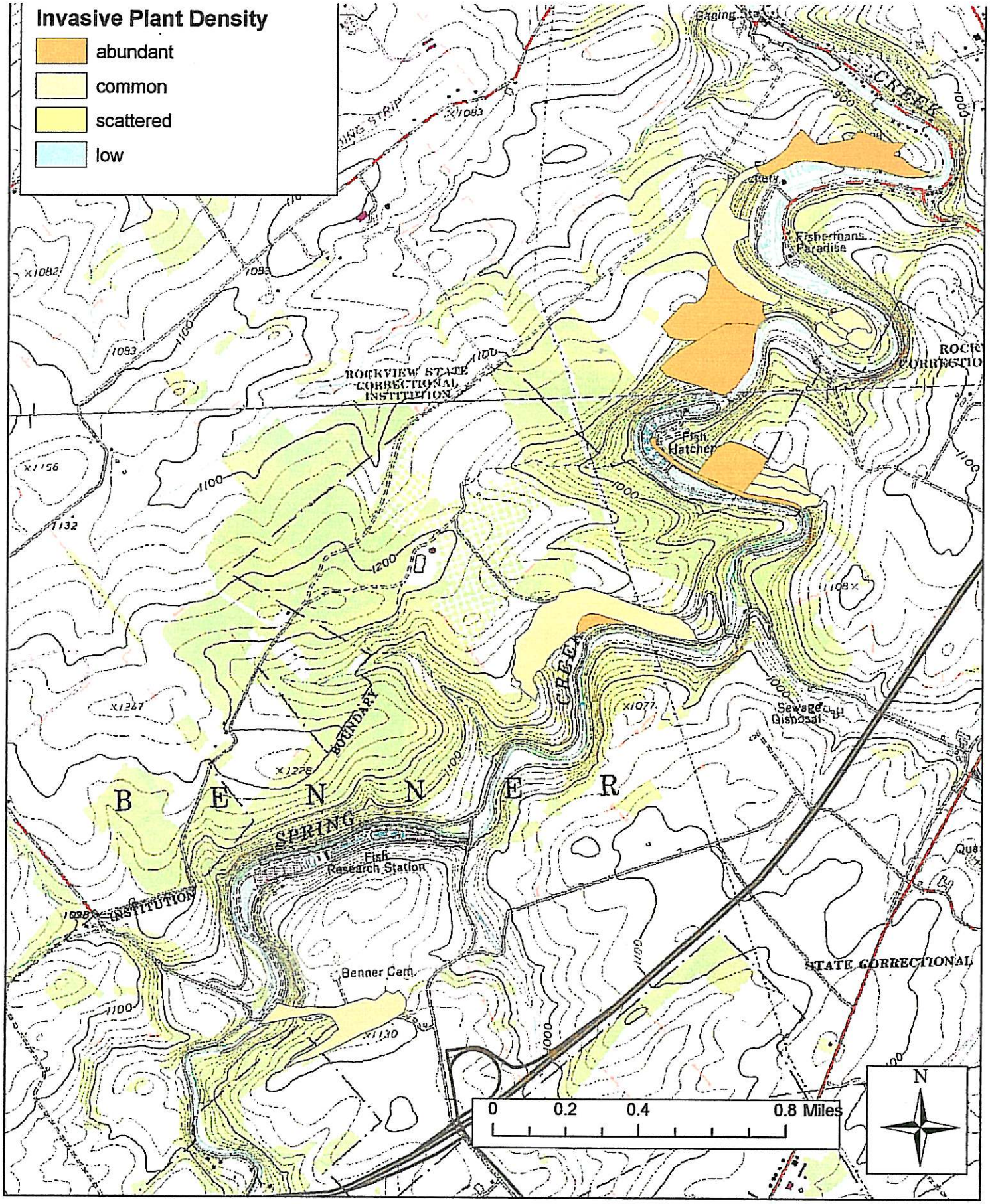


Figure 14. Density & Distribution of Amur honeysuckle (Lonicera maackii).
Estimated from field survey observations.

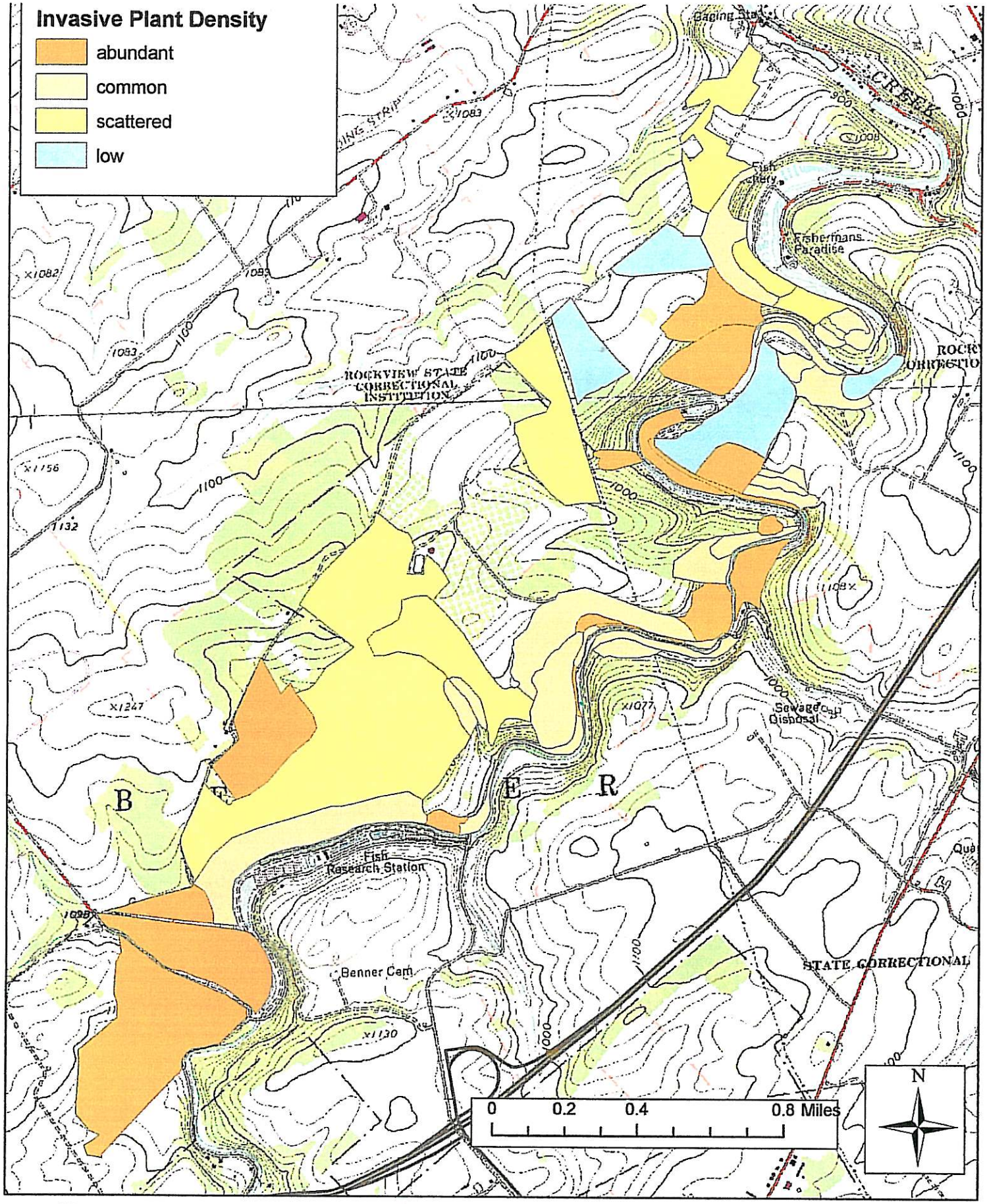


Figure 15. Density & Distribution of multiflora rose (Rosa multiflora).
Estimated from field survey observations.