A Survey of the Mammals Occurring at the Cove Point Liquefied Natural Gas Terminal Property Calvert County, Maryland

Final Report

Submitted by:

James M. McCann, Pete Bendel[1] and Dana Limpert[2]
MD Department of Natural Resources
Natural Heritage Program
P.O. Box 68
Wye Mills, MD 21679
Phone: (410) 827-8612
FAX: (410) 827-5186
email: jmccann@dnr.state.md.us

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To:

Cove Point Natural Heritage Trust, Inc.
P. O. Box 3466
218 Merrimac Court
Prince Frederick, MD 20678-1254

[1] MD DNR, Wildlife Division, Tawes State Office Bldg., E-1, 580 Taylor Ave., Annapolis, MD 21401, Phone: 410-260-8547, FAX: 410-260-8595, email: pbendel@dnr.state.md.us
[2] MD DNR, Natural Heritage Program, Tawes State Office Bldg., E-1, 580 Taylor Ave., Annapolis, MD 21401, Phone: 410-260-8556, FAX: 410-260-8595, email: dlimpert@dnr.state.md.us

Abstract – A mammal survey were conducted at the Cove Point Liquefied Natural Gas Terminal Property, Calvert County, Maryland during 2000-2001. The main goal of the survey was to document the mammalian fauna present at the site, including rare, threatened and endangered species. Of 44 potentially occurring species, 25 were confirmed present including *Sorex longirostris*, an uncommon mammal in Maryland that is confined to the southern portion of the Upper Coastal Plain and lower Piedmont physiographic regions. Two of the 19 undetected species (*Reithrodontomys humulis, Lynx rufus)*, both of which are state-listed, are presumed absent. For most of the remaining 17 undetected species, our surveys were inconclusive and these mammals should be regarded as possible occurrences. The apparent absence of at least some small mammal species was probably an artifact of our exceptionally low small mammal trap capture rates, which was thought to be due to a severe drought. Future surveys should focus on *Synaptomys cooperi* and *Myocastor coypus*; neither was detected despite intensive surveys. The former may be experiencing a decline in Maryland and little is known about its distribution, abundance or ecological requirements. The status of *Myocastor coypus* should be closely monitored. If a population becomes established at Cove Point, this introduced species could seriously degrade Cove Point Marsh, a unique, biological rich nontidal wetland that supports 41 state-listed plant taxa. Future surveys should also target bats, a group that was probably underrepresented in our surveys and includes many species whose conservation status in the state is uncertain.

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INTRODUCTION

The Cove Point Liquefied Natural Gas (LNG) Terminal Property is located in southeastern Calvert County, Maryland (approximately 38° 23' north latitude, 76° 24' west longitude) within the Upper Coastal Plain physiographic region. The property encompasses 406 ha and contains a variety of land forms and habitat types. Of particular ecological significance is Cove Point Marsh, a 77 ha nontidal freshwater baymouth barrier wetland bordering the Chesapeake Bay (Sipple 1982, 1990). This unique, botanically rich area supports nearly 400 plant species including 41 taxa that are state-listed as Threatened or Endangered (Steury 1997, 1999). Much of the area (~ 250 ha) surrounding Cove Point Marsh consists of shallow forested ravine systems with moderate to steep slopes and dendritic drainage patterns. Many of the ravines contain low-gradient 1st order and intermittent non-tidal streams, beaver impoundments (both abandoned and active) and upland seepage wetlands. The upland flora on the property has been described by Steury (1999, 2000) who recorded the presence of 696 plant species, including 31 state rare, Threatened or Endangered taxa. Typically, the upland forest canopy is dominated by mature black oak (Quercus velutina), white oak (Q. alba), scarlet oak (Q. coccinea), chestnut oak (Q. prinus), mockernut (Carya tomentosa) and pale hickory (C. pallida) with occasional Virginia pine (Pinus virginiana) and loblolly pine (P. taeda). In ravine bottoms and more mesic soils, tulip poplar (Liriodendron tulipifera), red maple (Acer rubrum), sweetgum (Liquidambar styraciflua) and American hornbeam (Carpinus caroliniana) tend to predominate. The mid- and understory are dominated by American holly (Ilex opaca), blueberries (Vaccinium corymbosum, V. pallidum), huckleberries (Gaylussacia baccata) and, in many areas, dense patches of mountain laurel (Kalmia latifolia). Of the remaining non-forested upland areas, the LNG industrial complex occupies 44 ha. The site also contains several small managed fields and freshwater impoundments.

The Cove Point area has been the subject of considerable ecological interest. Owned by the Cove Point LNG Limited Partnership, the property is subject to a conservation easement with Maryland Environmental Trust and The Nature Conservancy. To date, biological inventories have targeted vascular plants, odonates, fishes, amphibians, reptiles and birds. Orr (1999) noted the presence of 12 mammal species during his 1998-99 odonate surveys at Cove Point but, so far, there has been no systematic survey of the mammals present on the property. The purpose of this study is to document the mammalian fauna present. Approximately 44 species of mammal representing 16 different families may occur at Cove Point (Table 1) (Paradiso 1969, Linzey 1998, Whitaker and Hamilton 1998). Many of these species are common, widespread and undoubtedly present (e.g., White-tailed Deer [*Odocoileus virginianus*], Raccoon [*Procyon lotor*], Eastern Gray Squirrel [*Sciurus carolinensis*]). Others are cryptic, secretive, nocturnal or otherwise difficult to detect (e.g., bats, many small mammal species, certain carnivores). Their presence is unknown or less certain and effective detection of such species requires specialized survey techniques.

The objectives of our inventory were as follows:

(1) Develop a list of mammal species occurring at Cove Point.

(2) Determine the presence/absence, habitat association and relative abundance of the following uncommon and state rare, threatened and endangered species (Anonymous 2001):

		Status[Anonymous, 1997]
Southeastern Shrew	Sorex longirostris	G5/S3S4
Southern Pygmy Shrew	Sorex hoyi winnemana	G5T4/S2
Bobcat	Lynx rufus	G5/S3, In Need of Conservation
Eastern Harvest Mouse	Reithrodontomys humulis	G5/SH, State Endangered/Extirpated
Southern Bog Lemming	Synaptomys cooperi	G5/S3

(3) Describe the species composition of the mammalian fauna occurring in each of the major habitat types (e.g., upland mature deciduous forest, Cove Point Marsh, old fields, etc.).

METHODS

Surveys focused on small mammals, bats and carnivores because these mammals can be difficult to detect or require specialized techniques to determine their presence. These groups also included our primary target species (see objective 2 above) and other mammals of conservation or ecological interest (e.g., all bats; far-ranging, area-sensitive carnivores like *Lutra canadensis*; *Sorex cinereus*, whose distribution in eastern Maryland is uncertain).

In developing our inventory design, we reconnoitered the property to evaluate the types of habitats present and their distribution. We also examined remote sensing/GIS data (e.g., aerial photos; National Wetland Inventory, USGS 7.5' topographic and USDA county soils maps) and reviewed ecological and physical descriptions of the site (e.g., Sipple 1982, 1990; Steury 1997, 1999, 2000; MD Natural Heritage Program's Biodiversity Conservation Database). Survey sites were selected non-randomly based on their potential to support rare species. We also surveyed a variety of different habitats in an attempt to document all potentially occurring small mammal species.

Small Mammals

Small mammal surveys were conducted at seven sites representing three broad habitat types: forest ravines, old fields and beach/marsh. Site locations are shown in Figure 1.

Forest Ravines - The majority of our small mammal survey effort occurred in forest ravines (site nos. 1-3). We focused on these areas because: (1) forest ravines contain potential habitat for *Sorex longirostris, Sorex hoyi winnemana, Synaptomys cooperi* and most other potentially occurring small mammal species at Cove Point; (2) forest ravines contain a full range of the forest habitat conditions found at Cove Point (e.g., from seepage wetlands and floodplain forests to xeric ridgetop forests); (3) forest ravine systems are the dominant natural terrestrial habitat feature at Cove Point; and (4) by simultaneously surveying multiple ravine sites and representative habitats within each ravine, we hoped to characterize (i.e., in terms of species composition and relative abundance) the small mammal communities occurring in these areas.

We used pitfall traps at site nos. 1-3 during October 5-November 14, 2000 and April 2-May 23, 2001. Pitfalls were used because they are an effective survey technique for most small

mammals, especially for small shrews (*Sorex* sp., *Cryptotis* sp.), which can be difficult to detect using other methods (e.g., snap-traps, Sherman live-traps) (Bury and Corn 1987, Handley and Kalko 1993, Kalko and Handley 1993). Each site was dominated by mature oak-hickory forest with moderate to steep slopes and an elevational difference of 30-40 m from ravine bottom to ridgetop. The ravine bottoms were generally oriented along a north-south axis and each contained an intermittent stream. All sites were situated at least 300 m from the nearest nonforested areas.

A total of 45 pitfall traps were set per site. Within each site, 15 traps were set at 5 m intervals along three roughly parallel transects. One transect was set along the length of the ravine bottom, another approximately mid-way up an adjacent slope, and the third transect was set along the ridgetop. The three slope positions are referred to as ravine bottom, mid-slope and ridgetop, respectively. By using this trap placement, we sampled the typical range of forest habitat conditions found within a ravine.

Pitfall traps consisted of plastic cylinder containers measuring 21 cm deep with a top diameter of 21 cm and a bottom diameter of 21 cm. Traps were buried with the rim flush to the ground using a post-hole digger. Each trap was then half-filled with water and sealed with a plastic lid. All traps were left in place with lids on (to prevent inadvertent captures) for a period of at least one week. This "acclimation period" was used to minimize any effect that site disturbance or between site differences in the number of days between trap set-up and trap opening might have on mammal capture rates. Traps were opened on October 5, 2000 and checked every 5-7 days. The fall 2000 trap period ended on November 14, 2000 when all traps were closed; i.e., water and debris was removed, traps were sealed with lids and left in the ground. Traps were again opened during April 2 to May 23, 2001 when traps were closed and later removed.

In addition to pitfall trapping, we used snap traps (Victor professional mouse traps baited with a peanut butter and oats mixture) during October 16-18, 2001 at site no. 1 and along a nearby, old beaver impoundment (site no. 6) in the upper portion of the same ravine system. The main target species in this trapping effort was *Synaptomys cooperi*. At site no. 1, 18 traps were placed in rodent surface runways in small herbaceous opening in the ravine bottom and along several small (< 0.1 ha), sphagnum-sedge dominated seepage wetlands. At site no. 6, 21 traps were set in an open, wet sedge-dominated meadow (~ 0.4 ha) through which a small (< 2 m wide) intermittent stream meandered. Beavers abandoned this site sometime in the last few years.

Old Fields **-** During April 6-May 23, 2001, we pitfall trapped two field areas (site nos. 4-5). At each site, we set 25 pitfalls arranged in a 5 m by 5 m grid in the approximate center of the field. The main target species here was *Reithrodontomys humulis* but we were also interested in documenting the presence of other field-associated mammals (e.g., *Cryptotis parva*, *Microtus pennsylvanicus*) that were unlikely to be detected at our forest ravine trap sites.

During October 16-18, 2001, we also set 25 snap traps at site no. 5; again, Eastern Harvest Mouse was the main target species. Traps were placed at irregular intervals throughout the field in rodent surface runways.

Beach/Marsh – During October 16-18, 2001, 40 snap traps were set in the Cove Point Marsh area. *Oryzomys palustris* and *Cryptotis parva* were among the target species. Traps were placed at irregular intervals in the marsh, along the beach-marsh edge, and along the inland or back side of the beach.

For each of the above seven trap sites, all captured mammals were collected, identified by species and measured (total length, tail length, right hind foot and right ear length). If possible, sex was determined. Captured amphibians and reptiles were also identified and released nearby if alive (as in most cases). Mammal specimens have been catalogued and temporarily vouchered in the collection of J. M. McCann, MD DNR, Natural Heritage Program.

Carnivora

The presence of mammalian carnivores was documented primarily by searching suitable habitat for sign (e.g., tracks, scat, hairs caught on fences, etc.). Sign was noted during each site visit. Also, on several occasions during late summer-early fall 2001, we intensively searched those areas where evidence of certain species, if present, was likely to be found (e.g., the Cove Marsh area for *Lutra canadensis* and *Mustela vison*; ravine bottoms and the gas line rights of way for canids and *Lynx rufus*).

Chiroptera

Bats were surveyed using mist nets and bat detectors on four evenings at a total of five sites (Figure 1):

Site A - June 13, 2001, ~ 2000-2300 h, forest opening over manmade stream catch basin with open water and cattails, used three 12 m canopy nets, one 6 m canopy net and bat detector.
Site B - June 21, 2001, ~ 2000-2230 h, forest opening along gas line right-of-way, used three 12 m canopy nets and bat detector.
Site C, D and E - August 16, 2001, ~2000-2300 h, C and D located in large forest openings along Lake Levy, E located in dry, sandy, sparsely vegetated opening along far eastern corner of Cove Point Marsh, used bat detector only.
Site E - August 27, 2001, ~ 2000-2200 h, same location as described above, used three 6 m canopy nets and bat detector.

Bats were captured using one to three black, nylon, 36 mm mesh, 70 denier mist nets 6 m and 12 m in length stacked vertically, in accordance with Gardner et al. (1989). As described above, net rigs were set up over a small forested impoundment, gas line right-of-way, and forest opening. Trapping over natural flyways and water provides the least amount of site bias associated with these methods since all species in an area use flyways and need to drink (Kunz and Kurta 1988; Handley 1968; Tuttle 1974, 1976; Tidemann and Woodside 1978). An Anabat II ultrasonic bat detector (Titley Electronics, Ballina NSW, Australia) was used to monitor bat echolocation calls for identifying areas conducive for trapping. Bats were extracted and placed immediately in holding bags (similar to commercially available bird holding bags) for weighing (Kunz and Kurta 1988). Other data collected from individual bats include species, net height where captured, sex, age, reproductive condition and forearm measurement (Racey 1988, Anthony 1988). Mist nets were kept open from dusk until conditions warranted closure of nets (no

activity, capture success or poor weather conditions). Bats can detect nets more easily on windy (10 mph or greater) or rainy evenings (O'Farrell and Bradley 1970).

Other Mammal Species

Observations of other mammal species and their sign were noted throughout the project period. Examples of sign included tracks, scat and burrows.

RESULTS AND DISCUSSION

Overview

Twenty-five (57%) of the 44 potentially occurring species were confirmed present at Cove Point including *Sorex longirostris*, one of our primary target species (Table 1). Of the 19 undetected species, at least two (*Reithrodontomys humulis, Lynx rufus*) are probably absent given their regional rarity (or presumed extirpation in the case of *Reithrodontomys humulis*), known distribution, current habitat conditions and the amount of survey effort invested at Cove Point.

Three other species that were not found (*Cryptotis parva, Zapus hudsonius, Glaucomys volans*) should be considered probable occurrences. Each is common and widespread in southern Maryland and suitable habitat was clearly present for all three species. Detection of *Glaucomys volans*, a nocturnal arboreal species, usually requires specialized techniques (e.g., baited Havaharts); we were not able to conduct such surveys because of time and financial constraints. The lack of *Cryptotis parva* and *Zapus hudsonius* captures is probably related to our low overall pitfall trap capture rate (see discussion below). Additional pitfall surveys in appropriate habitat will likely confirm their presence.

For the remaining 14 undetected species, our surveys are inconclusive; these mammals should be regarded as possible occurrences at Cove Point. Some of these species (e.g., certain small mammals and bats), if present, may occur at low densities and our survey effort could have been insufficient to detect them. For others, more specialized techniques (e.g., *Condylura cristata* – modified Sherman live traps placed in partially excavated tunnels suspected of being made by this mole) or species-specific searches (e.g., *Myocastor coypus*, more intensive search for scat and tracks in Cove Point Marsh) may be required.

The extremely low capture rate using pitfall traps (0.23 animals per 100 trap nights, see Table 2) bears some mention. These traps were our primary means of surveying for four of the five target species and all potentially occurring small mammals. Despite a substantial survey effort (total of 14,770 pitfall trap nights using 185 traps at 5 sites; see Table 2), relatively few animals and species were captured. For comparison, we examined the mean pitfall capture rate at 29 other forest and field locations in the Upper Coastal Plain and Piedmont during 1992-2000 and found that the capture rate was 1.1, over five times that at Cove Point (McCann 1992; McCann, J. M. and D. F. Feller, unpublished data). These surveys involved the same type of pitfall and trapping procedures as those used at Cove Point and the surveys included both spring and fall trapping periods.

Reasons for the low capture rate at Cove Point are uncertain. Pitfalls are widely considered an effective trapping technique for small mammals, especially soricids (e.g., Bury and Corn 1987, Handley and Kalko 1993, Kalko and Handley 1993). They have been used successfully throughout the state in surveys for small mammals, including rare species (e.g., McCann 1992; McCann, J. M. and D. J. Feller, unpublished data). One possible contributing factor was the severe drought in fall 2000 during which the month of October 2000 was the driest ever recorded in Maryland. The capture rate may have been exceptionally low then because drought conditions can greatly limit above ground activity of many small mammal species, especially soricids (Churchfield, 1990), thus reducing the likelihood of capture. Comparisons of fall 2000 vs. spring 2001 capture rates for forest ravine site nos. 1-3 (Table 3) provides some support for this idea. In spring 2001, when precipitation levels began to return to normal, the capture rate was still low but over three times higher than in fall 2000. Low pitfall capture rates were also reported during this period by investigators at Patuxent Wildlife Research Center and on the Eastern Shore (Peter Osenton, personal communication). Admittedly, the differences in capture rate also could have been due to population recruitment in the spring, seasonal differences in above ground activity patterns, or some other unknown factors. Still, given our low capture rate, inferences regarding presence/absence, habitat associations, abundance and community composition should be viewed with caution. The low capture rate also prohibited any meaningful statistical comparisons of small mammal capture data (e.g., abundance comparisons among sites and habitats).

Primary Target Species

Sorex longirostris - The capture of seven *Sorex longirostris* at three sites was noteworthy (Table 2). This species has been found at only two other localities in Calvert County (Camp Roosevelt, Chesapeake Beach) and the most recent record is from 1925 (Paradiso 1969). Six individuals were caught in forest ravines (site nos. 1 and 3) and one was captured in an old field (site no. 5). At site no. 1 (a forest ravine), it was the second most frequently detected species (Table 2). Of the six specimens found in forest ravines, three were caught at mid-slope. The habitat there consisted of mesic, mature (~60-70 years old), closed canopy forest dominated by 25-50 cm dbh oaks (*Quercus velutina, Q. alba, Q. prinus*), *Acer rubrum*, *Nyssa sylvatica* and *Carya tomentosa* with dense patches of *Kalmia latifolia*. The forest floor had a thick leaf litter with moderate densities of dead and downed woody debris (e.g., logs, stumps, root mounds) and generally lacked herbaceous vegetation. The slopes were northeast to east-facing with moderate to steep (> 15%) slopes. The other three captures in forest ravines were all confined to the ridgetops. These xeric, mature (~60-70 years old), closed canopy forests were dominated by 25-40 cm dbh Q. prinus, *Q. alba* and *Pinus virginiana*. The understory and forest floor were usually open with a thick leaf litter and moderate amounts of dead and downed woody debris. The single specimen at site no. 5 occurred in a xeric old field dominated by dense 1 m tall *Andropogon virginicus* and *Rubus cuneifolius* with scattered *Juniperus virginiana* and other small trees.

The lack of *Sorex longirostris* captures in the forest ravine bottoms was unexpected. Although this species occurs in a variety of habitats, from old fields and clearcuts to mature deciduous forest, it tends to be most abundant in moist to mesic forested sites with a dense understory and abundant dead and downed woody debris (French 1980a, 1980b; McCann 1992; McCann, J. M., unpublished data). Many of the areas along the ravine bottoms and adjacent

slopes fit this description and it has been found in similar habitats elsewhere in southern Maryland (McCann 1992; McCann, J. M., unpublished data). The lack of captures in ravine bottoms may have simply been an artifact of our overall low pitfall capture rate. With additional trapping, we believe that it is likely to be found in these areas.

Maryland represents the northeastern periphery of the Southeastern Shrew's range . Its distribution in the state is confined to the lower Western Shore and lower Piedmont where it has been reported from 26 localities in six counties (Anne Arundel, Charles, Calvert, Montgomery, Prince George's, St. Mary's) (Paradiso 1969; Hall 1981; Hench 1987; Rambo, 1997; McCann 1992; McCann, J. M., unpublished data; Davis, C., unpublished data). Throughout most of its range, it exhibits contiguous allopatry with *Sorex cinereus* (French 1980b; Pagels and Handley 1989; Linzey 1998; McCann, J. M., unpublished data), which seems to be the case at Cove Point although an unusual instance of sympatry was reported in St. Mary's County (Rambo 1997). In appropriate habitat (see above), it can be among the most common small mammal species present. The species' current State Rank of S3S4 is a reflection, in part, of its restricted MD distribution and the limited number of records. Globally, the species is secure (Global Rank = G5).

***Sorex hoyi winnemana* -** Although not detected, this species should be regarded as a possible occurrence at Cove Point. The Southern Pygmy Shrew is the smallest mammal in North America and, until recently, was considered one of the rarest mammals (Whitaker and Hamilton 1998). With the recent advent of pitfall trapping as a commonly used survey method for small mammals, its apparent rarity is now being reconsidered. In Maryland, however, it remains as one of the most secretive and seldom observed mammals. A total of only 15 specimens are known from 11 widely scattered localities in six counties (Baltimore, Carroll, Harford, Montgomery, Prince Georges) (Preble 1910; Lee 1974; Hench, J., unpublished data; Laerm et al. 1993; McCann, J. M., unpublished data). Most specimens have been found in mature mesic forest, although it is apparently not tied to a particular forest type and it has been found in young, early successional forests. Captures usually occur only after a substantial trap effort using pitfalls has been made and the extremely low capture rate suggests that it may be present only in very low densities. The only known specimens (3 total) from the Maryland Coastal Plain were collected in 1993 from two localities in Prince Georges County (McCann, J. M., unpublished data).

Given the extent of apparently suitable habitat (mature mesic forest) at Cove Point, *Sorex hoyi winnemana* may yet be found with additional pitfall trapping. This taxon is currently ranked as G5T4/S2, reflecting its relatively secure global status but apparent rarity in Maryland. State listing is not warranted at this time because of the lack of information regarding its distribution, abundance, ecological requirements and threats.

***Reithrodontomys humulis* –** This species was not detected and its occurrence at Cove Point seems highly unlikely. It has not been found in Maryland since 1934. It is associated with old fields, wet meadows and occasionally cultivated grain fields (Paradiso 1969, Webster et al. 1985, Cawthorne and Rose 1989). Only two areas (site nos. 4-5), each containing old fields, appeared to contain suitable habitat and both were intensively trapped.

The occurrence of Eastern Harvest Mouse in Maryland is based on a single historical record dating back to 1934 (Paradiso 1969). The collector reported capturing three individuals near Riggs Mill (Takoma Park), Prince Georges County. One of the specimens is in the USNM collections; the fate of the other two is unknown. Howell (1940) reported examining two specimens from that same area but the location of these specimens is also unknown. There have been two reports of possible nests. Both, interestingly, are from Patuxent Wildlife Research Center. One was reported by Hotchkiss and Stewart (1979) and another was found just recently in March, 2001 (Richard Orr, personal communication); neither, however, could be confirmed as Eastern Harvest Mouse nests. Bailey (1923) mentioned finding numerous skulls of this species in owl pellets (Common Barn-Owl?) in the Smithsonian Tower in Washington, D.C. However, no specimens were collected and it seems unlikely that the animals were captured in Maryland since the nearest Maryland-DC border is 6-7 km to the east. Possibly, the source of the skulls is from just across the Potomac River in Virginia.

The s-rank for *Reithrodontomys humulis* is SH and it is currently state-listed as Endangered/Extirpated. Maryland represents the northeastern periphery of the species' range. Historically, its Maryland distribution was probably confined to the Upper Coastal Plain and perhaps the lower Piedmont. Just over the Potomac River, it is common in Virginia (s-rank = S5) and throughout the southeastern U.S. Globally, the species is secure (g-rank = G5).

***Synaptomys cooperi* –** Although not detected, this species should be regarded as a possible occurrence at Cove Point. It is thought to occur statewide but is probably rare to locally common. It has been found in a wide range of habitats from sphagnum bogs to a variety of different forest types, as well as old fields, marshes and orchards (Linzey 1983). Its chief habitat requirement seems to be abundant green, succulent monocots, primarily grasses and grasses. We intensively trapped such areas - ravine bottoms and seepage wetlands at site nos. 1-3, old fields at sites 4-5, beaver meadow at site no. 6, edge of Cove Point Marsh at site no. 7). When using snap traps, we also searched surface runways for bright green fecal pellets and small piles of neatly cut grasses and sedges (diagnostic sign for *Synaptomys cooperi*) but none were found.

The distribution and ecological requirements of Southern Bog Lemming in Maryland are poorly known. There is concern that it may be declining due to competitive exclusion by expanding Meadow Vole populations (Krupa and Haskins 1996). The presence of Southern Bog Lemming may be tied to small to medium-sized forest openings (e.g., bogs, seepage wetlands, wet to mesic native grassland communities) embedded in a large forest matrix where, historically, Meadow Voles were probably lacking (Linzey 1981, Krupa and Haskins 1996). In an increasingly fragmented landscape dominated by large open areas (e.g., pasture, cropland, strip-mined areas) with grassy corridors serving as dispersal routes (e.g., highway and transmission line rights of way), large Meadow Vole populations may displace the smaller, less numerous and less fecund Southern Bog Lemming. Although not state-listed, it is currently a Watchlist species (s-rank = S3). State-listing may be warranted in the future as more information becomes available on its distribution, abundance, ecological requirements and threats.

***Lynx rufus* –** As with *Reithrodontomys hunulis,* Bobcat was not detected at Cove Point and we believe its occurrence is highly unlikely. Potential habitat, including travel corridors (e.g.,

gas line rights of way, old forest roads, streamside areas, Cove Point marsh and beach), was intensively searched for tracks and scat. Although we were able to find sign for most other potentially occurring carnivores (see "Carnivora" section below), no Bobcat sign was found.

Historically, Bobcat occurred statewide and was considered common in many areas. Presumably, it once occurred at Cove Point but no supporting records are known. It has long been extirpated from the Delmarva Peninsula and probably most of the Upper Coastal Plain and Piedmont (Paradiso 1969; Robert Colona, personal communication). It is, at best, rare in southern Maryland and probably extirpated from most of the region. The last confirmed record of a Bobcat in southern Maryland was from Stump Neck, Charles County in 1992 when a single animal was observed in a large forested area (McCann 1992). Prior to that, the most recent record was from a swamp near Oxon Hill, Prince George's County in 1941 where a female was shot (specimen at USNM) along with five others when the area was being razed for a development (Paradiso 1969). Paradiso (1969) also mentioned an unconfirmed report that "bobcats are presently residing in wild areas on his (Watson Perrygo, USNM, Division of Mammals) property near Port Tobacco in Charles County". Another unconfirmed report (1945 or 1946, date uncertain) exists for the "Cypress Swamp region of Calvert County" (Mansueti 1950). West of the Piedmont (i.e., in the Ridge and Valley and Allegheny Plateau physiographic regions), Bobcat is considered rare to uncommon.

Bobcat is currently state-listed as In Need of Conservation. The loss of this species from the majority of the state, and its likely absence at Cove Point, is probably due to a long history of persecution and bounties followed by forest loss and fragmentation. Today, its range is nearly restricted to relatively remote, large contiguous forest tracts in western Maryland. Occasional reports still occur in the Upper Coastal Plain and Piedmont but most are unconfirmed.

Small Mammals

A total of 57 small mammals representing 7 species were captured (Table 2). The most frequently captured species was *Peromyscus leucopus* (19 individuals) followed by *Mus musculus* (15), *Blarina brevicauda* (8), *Sorex longirostris* (7), *Oryzomys palustris* (4), *Microtus pennsylvanicus* (3) and *Microtus pinetorum* (1).

Forest Ravines (site nos. 1-3) – A total of 26 individuals and three species were captured in the forest ravine habitats (Table 2). *Peromyscus leucopus* was the most frequently captured species followed by *Sorex longirostris* and *Blarina brevicauda*. In many areas, we also observed *Tamias striatus* and surface runways and tunnels by *Scalopus aquaticus* were common in some upland forest areas. Other species that are probably present but went undetected are *Zapus hudsonius* and *Microtus pinetorum.* Both are fairly common and widespread in Maryland (Paradiso 1969) and suitable habitat was present at Cove Point. In southern Maryland, *Zapus hudsonius* is associated with mesic forests and floodplain forests (McCann, J. M., unpublished data). *Microtus pinetorum* is more of a habitat generalist and inhabits a variety of both young and mature mesic forest types, old fields and overgrown orchards (Smolen 1981). However, this species often occurs in low densities and may require a significant trap effort to detect. *Condylura cristata* occurs in a variety of nontidal wetland types including seepage wetlands and floodplain forests (Peterson and Yates 1980). In Maryland, it is widespread but apparently rare to locally common (Paradiso 1969, Lee 1987). Although we did find some surface tunnels in the

ravine bottoms and tunnel entrances along stream banks, we could not be certain that Star-nosed Moles made these (burrowing crayfish can make similar tunnels).

Old Fields (site nos. 4-5) – A total of 8 individuals representing five species were captured in this habitat (Table 2). We caught two individuals each of *Blarina brevicauda, Peromyscus leucopus* and *Microtus pennsylvanicus*. Only one *Sorex longirostris* and *Microtus pinetorum* were caught. Old field site no. 5 was the only site where we found *Microtus pinetorum*. Surface runways and tunnels made by *Scalopus aquaticus* were also observed. The apparent absence of *Cryptotis parva,* a frequent inhabitant of old fields and early successional habitat, may have been an artifact our overall low capture rate.

Old Beaver Meadow (site no. 6) – Using snap traps, the only mammal captured in this habitat was a *Peromyscus leucopus* (Table 2). We were hopeful that we would find *Synaptomys cooperi* in this moist herbaceous opening. However, our survey results here should be considered inconclusive given the low capture rate and relatively limited trap effort.

Cove Point Marsh/Beach (site no. 7) – The only species detected at this site were *Oryzomys palustris* (4 individuals) and *Mus musculus* (15 individuals) (Table 2). Small mammal communities in coastal marshes along the Chesapeake Bay are typically dominated by *Microtus pennsylvanicus* followed by *Oryzomys palustris* and perhaps *Blarina brevicauda* and *Cryptotis parva* (Paradiso 1969). The apparent absence of three of these species, especially *Microtus pennsylvanicus,* and the remarkably high relative abundance of *Mus musculus* was unexpected. High densities of *Mus musculus* in natural areas seems to be uncommon but it has been reported at Assateague Island (Cranford and Maly 1990) and Wallops Island (Kirkland and Fleming 1990) where it was the dominant species in dune habitats. At this Cove Point site, large numbers of *Mus musculus* may contributed to the apparent lack of native species through competitive exclusion (Webster et al. 1985). House Mice also may have "saturated" the trap line, reducing the likelihood of capturing other species. We believe that with additional trapping, using a combination of pitfalls and either Sherman live traps or snap traps, other native species (e.g., *Microtus pennsylvanicus, Cryptotis parva, Blarina brevicauda*) are likely to be found. However, it may be necessary to first intensively trap the site for several days to temporarily reduce House Mice numbers so that other species can be more effectively detected. The residential areas along the southern border of the marsh probably provided a rich source of House Mice.

Carnivora

By searching for tracks and scat, we were able to confirm the presence of 7 of the 9 potentially occurring mammalian carnivores (Table 1). The beach and marsh edges along Cove Point Marsh provided an ideal tracking surface for detecting a variety of mammals. There, we found tracks and/or scat for *Vulpes vulpes, Procyon lotor, Mustela vison, Lutra canadensis* and *Mephitis mephitis*. Along trails, stream bottoms and the gas line right-of-way in the forested western part of the property, we also located tracks, hairs (caught on low branches) and/or scat of *Urocyon cinereoargenteus* and *Mustela frenata,* as well as *Vulpes vulpes, Procyon lotor* and *Mephitis mephitis.* On several occasions, we directly observed *Vulpes vulpes* in open mowed grassy areas along the access roads surrounding the large gas storage tanks in the center of the property. The presence of *Lutra canadensis, Mustela vison* and *Urocyon cinereoargenteus* is an indication of the size, contiguity and relatively undisturbed nature of the forested and marsh

habitats found at Cove Point and surrounding areas (e.g., Calvert Cliffs State Park to the north). All three of these species, especially *Lutra canadensis,* have relatively large home ranges and area requirements (Linzey 1998).

As discussed earlier, *Lynx rufus* is probably absent (see previous section "Primary Target Species"). *Canis latrans* also may be absent but we are less certain about its status at Cove Point; this species should be regarded as a possible occurrence. *Canis latrans* has a relatively large territory size and it is expanding its range into southern Maryland. If present, the number of animals occurring on the property may be so low or its presence so infrequent that sign could have been missed.

Chiroptera

Only two species of bat were confirmed present, *Eptesicus fuscus* and *Lasiurus borealis* (Table 1). The former was observed at site E on August 16, 2001 when the audible calls of several foraging individuals were heard in a dry, sparsely vegetated, sandy opening along the far eastern corner of Cove Point Marsh. This species is the only potentially occurring bat that emits sounds that are audible to humans (Fenton and Bell 1981). Another possible *Eptesicus fuscus* was visually observed at site A on June 13, 2001 but identification could not be confirmed. The presence of *Lasiurus borealis* was confirmed by the mist net capture of a male (42 mm forearm length, mass 14 g) at site A on June 13, 2001. This was the only mist net capture during our surveys. Generally, little (site A, C, D) or no (site B) bat foraging activity was observed except at site E where a moderate of foraging bat activity (i. e., several individuals) seemed to be present.

Several factors probably contributed to the lack of bats detected or captured at Cove Point. First, there was a lack of suitable mist net sites on the property. The most successful trap sites are those that serve as bat travel lanes or foraging/drinking areas, such as along streams, forested wetlands, roads and trails. Optimal sites are relatively small forest openings with mature trees along the edges which help "funnel" bats into the nets. Such areas must be wide enough to accommodate nets 6 m or 12 m in length. After searching for suitable trap sites, we found that most forest openings were either too small for the net rigs or so large that funneling effects may have been minimal.

A second possible factor was that the overall abundance of bats on the property seemed to be low. Bat detectors yielded very few calls (<20 calls per night) at most sites. The catch basin mist net site (Site A) appeared to be the most promising site but only three bats were observed and few calls (< 10) were recorded. The gas line right-of-way (Site B) also looked promising but no bat activity was observed at this site. With the bright lighting from the nearby plant, bats may spend little time foraging in this area because of increased exposure to predators (owls, perhaps caprimulgids) or perhaps because the white lights attract relatively few insects. The bat detector survey yielded the most echolocation calls at site E. Bats were observed actively foraging in this area for at least an hour. However, the sparsely vegetated, light sandy substrate and moonlit conditions may have illuminated the area enough that bats were able to avoid the mist nets. Breezy conditions also were a factor as a weak front passed through during the trapping period.

And finally, the lack of bat detections and captures may have been due to bats concentrating their feeding above the forest canopy, which would have made their detection and capture impossible.

Other Mammal Species

As indicated in Table 1, a number of other mammal species, all common and widespread in Maryland, were confirmed present: *Didelphis virginiana, Sylvilagus floridanus, Marmota monax, Sciurus carolinensis* and *Castor canadensis.* Although not detected, two introduced species (*Rattus norvegicus, Myocastor coypus*) should be regarded as possible occurrences. *Rattus norvegicus* may occur in and around the building sites and perhaps in low numbers in some natural habitats like Cove Point Marsh. However, no special effort was made to survey for this species so its status is uncertain on the property. Despite extensive searches for tracks and scat, no Nutria or their sign were observed in Cove Point Marsh. However, prior to this survey, a dead individual was reported there on September 3, 1999 (Orr 1999). Additional surveys are needed to determine this species' status.

White-tailed Deer densities seemed to be moderately high. Some of the mature forested areas appeared to be developing a browse line, indicating that deer numbers may be approaching carrying capacity.

Incidental captures of amphibians and reptiles

A total of 84 amphibians and reptiles representing 14 species were incidentally captured in pitfall traps in forest ravine site nos. 1-3 (Table 4). All but three animals were released alive near the trap site; the others were found dead and deteriorated in the traps and discarded at the site.

CONCLUSIONS

Although the majority of the potentially occurring mammal species were confirmed present, additional species are probably present. The apparent absence of some small mammals was likely an artifact of low trap rates and, in the case of bats, only moderately effective survey techniques. With advances in bat detector technology and the development of more accurate methods for identifying flying bats based on ultrasonic vocalizations, the effectiveness of bat inventory efforts will improve considerably. Bats should be an important focus of future biological inventory work at Cove Point as these advances are made.

Other species that warrant additional inventory work include *Synaptomys cooperi* and *Myocastor coypus*. Despite a substantial survey effort, we were unable to detect *Synaptomys cooperi*, a species that may be declining in Maryland. Little is known about its distribution, abundance or ecological requirements. Threats to this small, elusive mammal may include expanding *Microtus pennsylvanicus* populations and increasing habitat fragmentation. The status of *Myocastor coypus* at Cove Point should be closely monitored. Although we were unable to find any evidence of its occurrence, small numbers may be present. If a population becomes established it could seriously degrade Cove Point Marsh and threaten the site's unique wetland communities and their associated rare flora.

Future surveys should also target *Sorex hoyi winnemana*, an apparently rare species in Maryland for which basic distributional and ecological information is lacking. Pitfall surveys for this species should also serve as an effective method for capturing other undetected species including *Synaptomys cooperi, Zapus hudsonius* and *Cryptotis parva.*

The most effective conservation strategy for the mammalian fauna at Cove Point is to maintain and restore large, native forest and marsh ecosystems with adequate connectivity to surrounding areas to facilitate dispersal and gene flow. Also, in addition to monitoring Nutria, White-tailed Deer densities should be evaluated. Deer densities may be at or near carrying capacity. The negative ecological effects of high deer densities have been fairly well documented. Evaluation of current and potential deer densities will provide useful information for developing appropriate deer management strategies and thus help maintain the ecological integrity of the natural communities present at Cove Point.

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Table 1. A list of mammal species that were confirmed present at the Cove Point LNG Terminal Property, Calvert County, Maryland. Potentially occurring species are also listed. Classification generally follows that of Nowak (1991). The scientific and common names follow those of Jones et al. (1997).

		Status
Order Didelphimorphia		
Family Didelphidae		
Didelphis virginiana virginiana	Virginia Opposum	**PRESENT**
Order Insectivora		
Family Soricidae		
Sorex cinereus cinereus	Masked Shrew	Possible
Sores longirostris longirostris[S3S4]	Southeastern Shrew	**PRESENT**
Sorex hoyi winnemana[S2]	Southern Pygmy Shrew	Possible
Cryptotis parva parva	Least Shrew	Probable
Blarina brevicauda brevicauda	Short-tailed Shrew	**PRESENT**
Family Talpidae		
Scalopus aquaticus aquaticus	Eastern Mole	**PRESENT**
Condylura cristata cristata	Star-nosed Mole	Possible
Order Chiroptera		
Family Vespertilionidae		
Myotis lucifugus lucifugus	Little Brown Myotis	Possible
Myotis septentrionalis	Northern Myotis	Possible
Lasionycteris noctivagans	Silver-haired Bat	Possible
Pipistrellus subflavus subflavus	Eastern Pipistrelle	Possible
Eptesicus fuscus fuscus	Big Brown Bat	**PRESENT**
Nycticeius humeralis humeralis	Evening Bat	Possible
Lasiurus borealis borealis	Eastern Red Bat	**PRESENT**
Lasiurus cinereus cinereus	Hoary Bat	Possible
Order Lagomorpha		
Family Leporidae		
Sylvilagus floridanus floridanus	Eastern Cottontail	**PRESENT**
Order Rodentia		
Family Sciuridae		
Tamias striatus striatus	Eastern Chipmunk	**PRESENT**
Marmota monax monax	Woodchuck	**PRESENT**
Sciurus carolinensis carolinensis	Eastern Gray Squirrel	**PRESENT**
Glaucomys volans volans	Southern Flying Squirrel	Probable
Family Castoridae		
Castor canadensis	American Beaver	**PRESENT**
Family Muridae		
Oryzomys palustris palustris	Marsh Rice Rat	**PRESENT**
Reithrodontomys humulis humulis[X,SH]	Eastern Harvest Mouse	Absent?

Table 1. Continued.

Family Muridae (continued)		
Reithrodontomys humulis humulis[X,SH]	Eastern Harvest Mouse	Absent?
Peromyscus maniculatus bairdii	Prairie Deer Mouse	Possible
Peromyscus leucopus novaboracensis	White-footed Mouse	**PRESENT**
Microtus pennsylvanicus pennsylvanicus	Meadow Vole	**PRESENT**
Microtus pinetorum pinetorum	Woodland Vole	**PRESENT**
Synaptomys cooperi cooperi[S3]	Southern Bog Lemming	Possible
Ondatra zibethicus zibethicus	Muskrat	**PRESENT**
Rattus norvegicus norvegicus	Norway Rat	Possible
Mus musculus musculus	House Mouse	**PRESENT**
Family Zapodidae		
Zapus hudsonius hudsonius	Meadow Jumping Mouse	Probable
Family Myocastoridae		
Myocastor coypus	Nutria	Possible
Order Carnivora		
Family Canidae		
Vulpes vulpes fulva	Red Fox	**PRESENT**
Urocyon cinereoargenteus cinereoargenteus	Gray Fox	**PRESENT**
Canis latrans latrans	Coyote	Possible
Family Procyonidae		
Procyon lotor lotor	Raccoon	**PRESENT**
Family Mustelidae		
Mustela frenata frenata	Long-tailed Weasel	**PRESENT**
Mustela vison vison	Mink	**PRESENT**
Lutra canadensis lataxina	Northern River Otter	**PRESENT**
Family Mephitidae		
Mephitis mephitis mephitis	Striped Skunk	**PRESENT**
Family Felidae		
Lynx rufus rufus[I,S3]	Bobcat	Absent?
Order Artiodactyla		
Family Cervidae		
Odocoileus virginianus	White-tailed Deer	**PRESENT**

[X] - State listed as Endangered/Extirpated
[I] - State listed as In Need of Conservation
[S2] – State Rare. Typically, 6-20 occurrences in the State are known.
[S3, S3S4] – Watchlist. Typically, uncommon to rare with 21-100 occurrences known in the State.

Table 2. Summary of small mammal survey results by site and trap method during 2000-2001. Trap capture rates are shown in parentheses.

	Pitfall						Snap Trap					
Species	Forest Ravine Site No. 1	Forest Ravine Site No. 2	Forest Ravine Site No. 3	Old Field Site No. 4	Old Field Site No. 5	Total	Forest Ravine Site No. 1	Old Field Site No. 5	Beaver Meadow Site No. 6	Beach/ Marsh Site No. 7	Total	Total
Sorex longirostris	5 (0.12)	0	1 (0.02)	0	1 (0.09)	7 (0.05)	0	0	0	0	0	7 (0.05)
Blarina brevicauda	2 (0.05)	1 (0.02)	3 (0.07)	1 (0.09)	1 (0.09)	8 (0.05)	0	0	0	0	0	8 (0.05)
Oryzomys palustris	0	0	0	0	0	0	0	0	0	4 (5.00)	4 (1.92)	4 (0.03)
Peromyscus leucopus	7 (0.17)	5 (0.12)	2 (0.05)	2 (0.17)	0	16 (0.11)	2 (5.56)	0	1 (2.38)	0	3 (1.44)	19 (0.13)
Microtus pennsylvanicus	0	0	0	0	2 (0.17)	2 (0.01)	0	1 (2.00)	0	0	1 (0.48)	3 (0.02)
Microtus pinetorum	0	0	0	0	1 (0.09)	1 (0.01)	0	0	0	0	0	1 (0.01)
Mus musculus	0	0	0	0	0	0	0	0	0	15 (18.8)	15 (7.21)	15 (0.10)
No. Individuals Captured	14	6	6	3	5	34	2	1	1	19	23	57
Trap Capture Rate[1]	0.34	0.15	0.15	0.26	0.43	0.23	5.56	2.00	2.38	23.75	11.06	0.38
No. traps	45	45	45	25	25	185	18	25	21	40	104	289
No. Trap Nights[2]:												
Pitfall, Oct 5-Nov 14, 2000	1,845	1,845	1,845	0	0	5,535	0	0	0	0	0	5,535
Pitfall, Apr 2-May 23, 2001	2,295	2,295	2,295	0	0	6,885	0	0	0	0	0	6,885
Pitfall, Apr 6-May 23, 2001	0	0	0	1,175	1,175	2,350	0	0	0	0	0	2,350
Snap Trap, Oct 16-18, 2001	0	0	0	0	0	0	36	50	42	80	208	208
Total	4,140	4,140	4,140	1,175	1,175	14,770	36	50	42	80	208	14,978

[1] Trap capture rate = no. individuals captured/no. trap nights x 100.
[2] No. trap nights = no. traps x no. days traps were set

Table 3. Comparison of pitfall trap capture rates during fall 2000 and spring 2001[1]. Trap capture rates are shown in parentheses.

	October 5-November 14, 2000				April 2-May 23, 2001			
Species	Forest Ravine Site No. 1	Forest Ravine Site No. 2	Forest Ravine Site No. 3	Total	Forest Ravine Site No. 1	Forest Ravine Site No. 2	Forest Ravine Site No. 3	Total
Sorex longirostris	1 (0.05)	0	0	1 (0.02)	4 (0.17)	0	1 (0.04)	5 (0.07)
Blarina brevicauda	1 (0.05)	0	2 (0.11)	3 (0.05)	1 (0.04)	1 (0.04)	1 (0.04)	3 (0.04)
Peromyscus leucopus	0	0	1 (0.05)	1 (0.02)	7 (0.31)	5 (0.22)	1 (0.04)	13 (0.19)
No. Individuals	2	0	3	5	12	6	3	21
Trap Capture Rate[2]	0.11	0	0.16	0.09	0.52	0.26	0.13	0.31

[1] Trap periods: October 5-November 14, 2000; April 2-May 23, 2001. Forty-five traps were used at each site yielding 1,845 trap nights per site during fall 2000 and 2,295 trap nights per site during spring 2001.

[2] Trap capture rate = no. individuals captured/no. trap nights x 100.

Table 4. Summary of the reptiles and amphibians captured in pitfall traps at site nos. 1-5 during 2000-2001.

	Forest Ravine Site No. 1				Forest Ravine Site No. 2				Forest Ravine Site No. 3				Old Field Site No. 4	Old Field Site No. 5	Total
Species	Ridge	Mid-slope	Ravine Bottom	Total	Ridge	Mid-slope	Ravine Bottom	Total	Ridge	Mid-slope	Ravine Bottom	Total			
Ambystoma maculatum									1	1	5	7	1		8
Ambystoma opacum									2	1	2	5			5
Eurycea bislineata							1	1							1
Hemidactylium scutatum									1			1			1
Plethodon cinereus	1			1						2	2	4			5
Pseudotriton ruber			2	2						2	1	3			5
Bufo americanus	1		1	2	1	2		3	1			1			6
Hyla cinerea										1		1			1
Rana clamitans	1	2	11	14			5	5			2	2		1	22
Rana utricularia		1	3	4					3	7	6	16	1		21
Sceloporus undulatus	4			4											4
Eumeces laticeps						1		1	1			1			2
Chelydra serpentina							1	1							1
Terrapene carolina		1		1	1			1							2
Total No. Individuals	7	4	17	28	2	3	7	12	9	14	18	41	2	1	84
Total No. Species	4	3	4	7	2	2	3	6	6	6	6	10	1	1	14

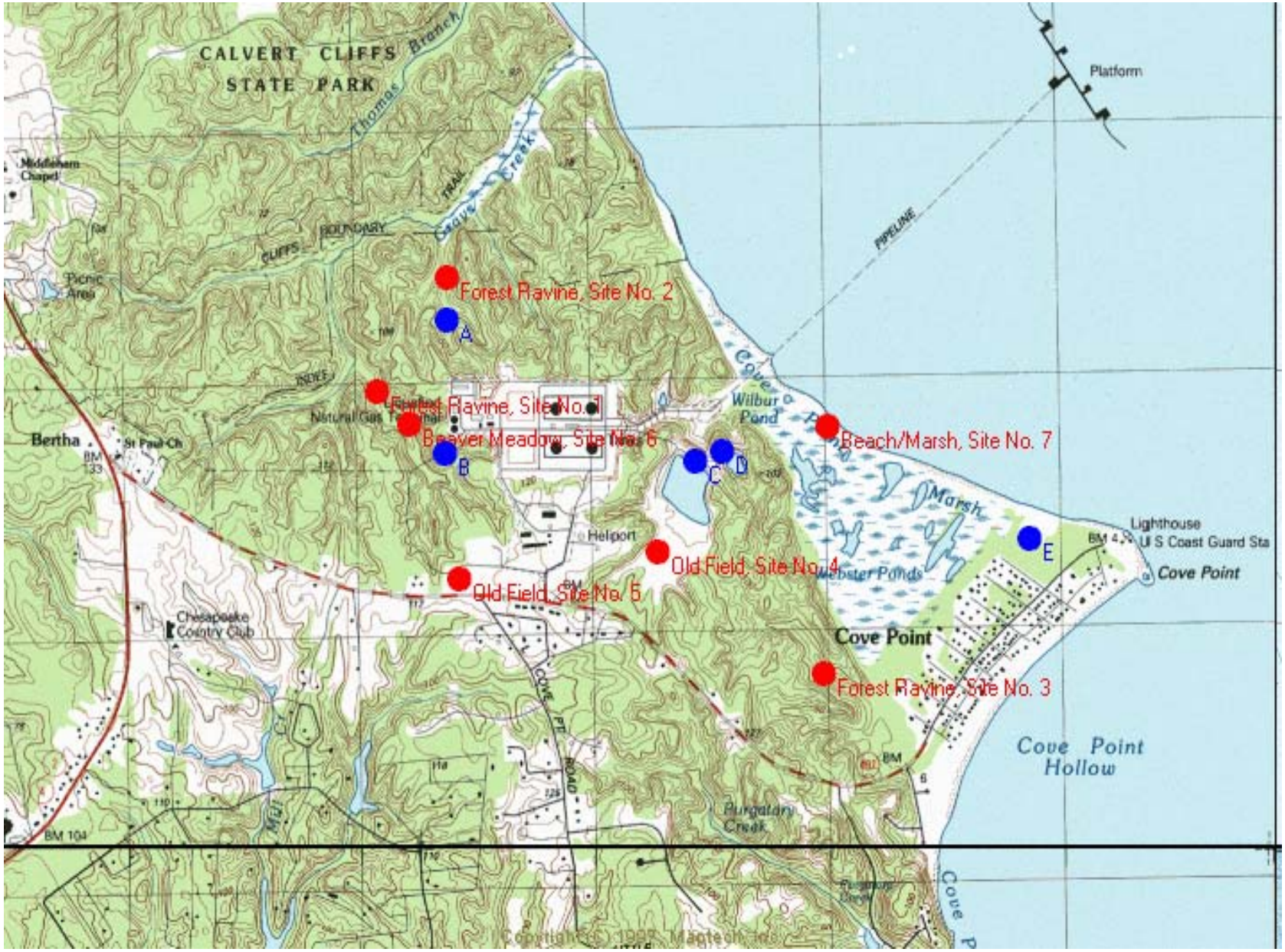

Figure 1. Locations of small mammal trap sites (numbered red circles) and bat survey sites (lettered blue circles) during 2000-2001 at Cove Point Liquefied Natural Gas (LNG) Terminal Property, Calvert County, Maryland. Site locations overlaid on Cove Point, MD USGS 7.5' quadrangle.