

FINAL REPORT - DNERR Comprehensive Site Description

Phase II - Characterization of Finfish and Aquatic Macroinvertebrate Communities and Waterbird Populations

PREPARED FOR

**Delaware National Estuarine Research Reserve
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway
Dover, Delaware 19901**

PREPARED BY

**Wetlands Research Associates, Inc.
102 East Main Street, Suite 305
Newark, DE 19711-7319
(302) 738-7535**

and

**Environmental Consulting Services
100 South Cass Street
P.O. Box 138
Middletown, DE 19709-0138
(302) 378-9881**

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Executive Summary

The Delaware National Estuarine Research Reserve (DNERR) system has been established as described in the *Delaware National Estuarine Research Reserve - Final Environmental Impact Statement/Draft Management Plan* (NOAA/DE DNREC, 1992) and the *Delaware National Estuarine Research Reserve - Final Management Plan* (NOAA/DE DNREC, 1993). The DNERR was designated by the National Oceanic and Atmospheric Administration in July, 1993 as the 22nd site in the National Estuarine Research Reserve System (NERRS). Two estuarine reserve components have been designated: Upper Blackbird Creek, New Castle County and Lower St. Jones River, Kent County.

The objectives and goals of the program center on the elements of resource protection, estuarine research, and environmental education. Resource protection will be afforded through acquisition of key property holdings that include marshland and upland buffer areas and through cooperative agreements with watershed landowners. Additionally, program recognition, research, and education activities will promote resource protection through landscape value awareness and supplemental stewardship programs.

The finfish community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 88 separate samples collected over three seasons, contained 9599 specimens of 34 species. The lower St. Jones River had more finfish species collected (25) than did upper Blackbird Creek (21). About equal numbers of finfish were collected in samples taken from each portion of the reserve.

Six species constituted over 92% of the total catch. In order of decreasing abundance, these species are listed with their percent of total taken: spot (33%), mummichog (17%), Atlantic menhaden (13%), Atlantic silverside (13%), white perch (10%), and sheepshead minnow (7%). These six species include two that are estuarine dependant (spot and Atlantic menhaden), and four that are estuarine resident (mummichog, Atlantic silverside, white perch and sheepshead minnow). The majority of spot, white perch, and all of the Atlantic menhaden were collected from upper Blackbird Creek, and the majority of mummichog, Atlantic silverside and all of the sheepshead minnow, were collected in the lower St. Jones River. For both areas of the reserve, the maximum numbers of finfish were collected in the summer, and the minimum numbers in the spring.

The benthic macroinvertebrate community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 88 petite ponar grab samples collected over three seasons, contained 37 taxa of 5 phyla: annelida, arthropoda, mollusca, platyhelminthes, and nemertea. More benthic macroinvertebrate taxa were collected in the lower St. Jones River (33) portion than in the upper Blackbird Creek (21).

Total mean density (n/m^2) of all taxa for both areas and all seasons was 3715. Nine taxa constituted over 90% of the total. In order of decreasing abundance, these taxa are listed with their mean densities (n/m^2) and percent of total taken: oligochaeta (2125, 57%), chironomidae (466, 13%), *Corophium* sp. (257, 7%), *Gammarus* sp. (106, 3%), *Edotea triloba* (87, 2%), *Neomysis americana* (86, 2%), polychaeta (85, 2%), *Streblospio benedicti* (72, 2%), and *Polydora ligni* (66, 2%). The seasonal total mean densities of benthic macroinvertebrate taxa were always higher in the lower St. Jones River than in the upper Blackbird Creek. The total mean densities for all taxa within each season were, for the St. Jones and Blackbird areas respectively; summer 3850 and 2040, fall 4352 and 3407, and spring 4573 and 4289.

In both study areas, and during each season, the single most abundant benthic macroinvertebrate taxon was the oligochaeta. With total mean densities (n/m^2) ranging from 826 to 2756, oligochaetes accounted for 41 to 63% of the total taxa collected. Oligochaete densities were higher in the St. Jones River than in the Blackbird Creek during the summer and fall. The total mean densities for oligochaetes for each season were, for the St. Jones and Blackbird areas respectively; summer 2191 and 826, fall 2756 and 2115, and spring 2562 and 2637.

The remainder of the taxa contributing to over 90% of the benthic macroinvertebrate densities collected from the Blackbird Creek during each season consistently included chironomidae, and *Corophium* sp. or *Cyathura polita*. In contrast, the equivalent taxa of the St. Jones aquatic macroinvertebrate community varied greatly from season to season.

The distribution of benthic macroinvertebrates between habitats was examined for both portions of the DNERR area. The mean annual densities (n/m^2) for habitats in both systems are given in decreasing order: St. Jones 2° channel (4400), Blackbird Creek tidal river (3840), St. Jones tidal river (3781), St. Jones secondary gut (2298), and the Blackbird creek secondary channel (2048) (Tables 28 and 29). The benthic macroinvertebrate densities of the tidal rivers of both systems were nearly identical.

Within all habitats (tidal river, secondary gut and secondary channel) in both the Blackbird Creek and the St. Jones River, the most abundant taxa was always the oligochaeta, annual mean densities (n/m^2) ranging from 1319 (St. Jones tidal river) to 3288 (St. Jones secondary channel), and which comprised 35 to 77 percent of the total mean annual benthic macroinvertebrate densities collected.

The three most abundant taxa in the tidal river stations of both portions of the reserve were identical, being oligochaeta, chironomidae, and *Corophium* sp. *Gammarus* sp. was in the top 90th percentile of both portions. The secondary channel stations in both portions differed greatly in the taxa comprising at least 90% of the total catch.

The parabenthic macroinvertebrate community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 28 0.5-meter 500 micron plankton net samples collected over three seasons, contained 13 taxa

of four phyla, the annelida, arthropoda, cnidaria, and ctenophora (Table 30). Slightly more taxa were taken in the upper Blackbird Creek (11) portion than the lower St. Jones River (9). Total mean densities ($n/100m^3$) of all taxa for both areas and all seasons was 4247. Two taxa constituted over 93% of the total, with one of them, the opossum shrimp *Neomysis americana*, being predominant in the collections, with a total mean density of 3807, and was responsible for nearly 90% of the total taxa collected.

Wading bird species and numbers were comparable between the two reserve creeks, although the habitats differed. Mid Blackbird Creek site has significant mud flats, while the St. Jones River site has the pools of the Morris Farm pond and the Logan Tract. No shorebird habitat occurs within the Blackbird reserve, while extensive habitat lies within the St. Jones reserve area.

As an indication of species diversity, the number of species observed are shown against the number of visits (number of species/visits to observation points) in Tables 35 and 36. On this basis the two reserves and most point are comparable. The greatest number of species/visit were observed near the mud flats (Harvey Farm and Kershaw property) on Blackbird Creek and in the pools on the St. Jones River.

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Introduction

The Delaware National Estuarine Research Reserve (DNERR) system has been established as described in the *Delaware National Estuarine Research Reserve - Final Environmental Impact Statement/Draft Management Plan* (NOAA/DE DNREC, 1992) and the *Delaware National Estuarine Research Reserve - Final Management Plan* (NOAA/DE DNREC, 1993). The DNERR was designated by the National Oceanic and Atmospheric Administration in July, 1993 as the 22nd site in the National Estuarine Research Reserve System (NERRS). Two estuarine reserve components have been designated: Upper Blackbird Creek, New Castle County and Lower St. Jones River, Kent County. Figures 1 and 2 show the maximum proposed size and boundaries of each component with participation by landowners within each site on a voluntary and cooperative basis. The objectives and goals of the program center on the elements of resource protection, estuarine research, and environmental education. Resource protection will be afforded through acquisition of key property holdings that include marshland and upland buffer areas and through cooperative agreements with watershed landowners. Additionally, program recognition, research, and education activities will promote resource protection through landscape value awareness and supplemental stewardship programs.

On May 19, 1994, WRA initiated Phase II of the DNERR Comprehensive Site Description. Phase II primarily involved the characterization of finfishes, aquatic macroinvertebrates, and avian communities within the areas of the Upper Blackbird Creek and Lower St. Jones River estuary reserve sites. WRA was responsible for overall project management and for the avian community surveys.

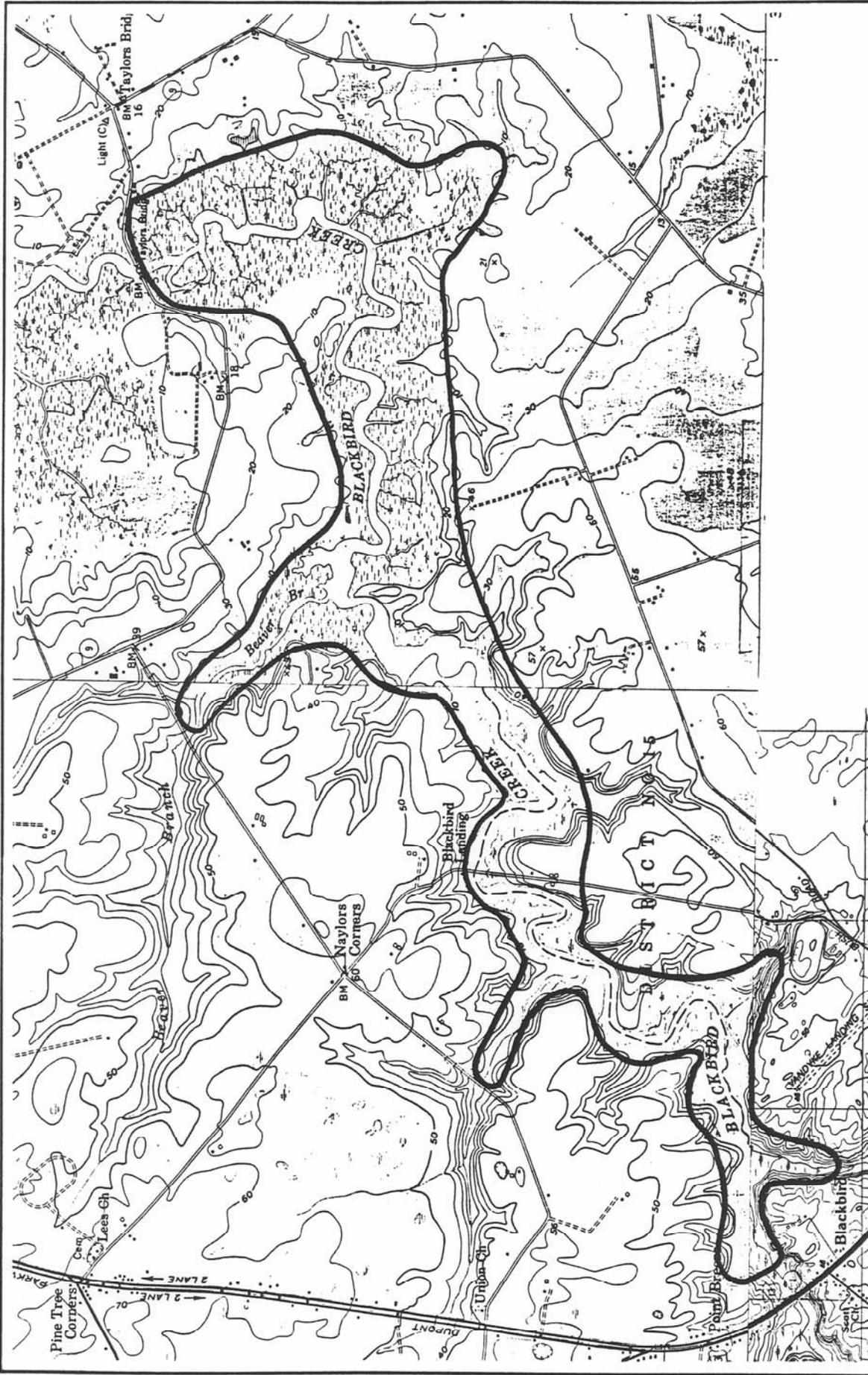
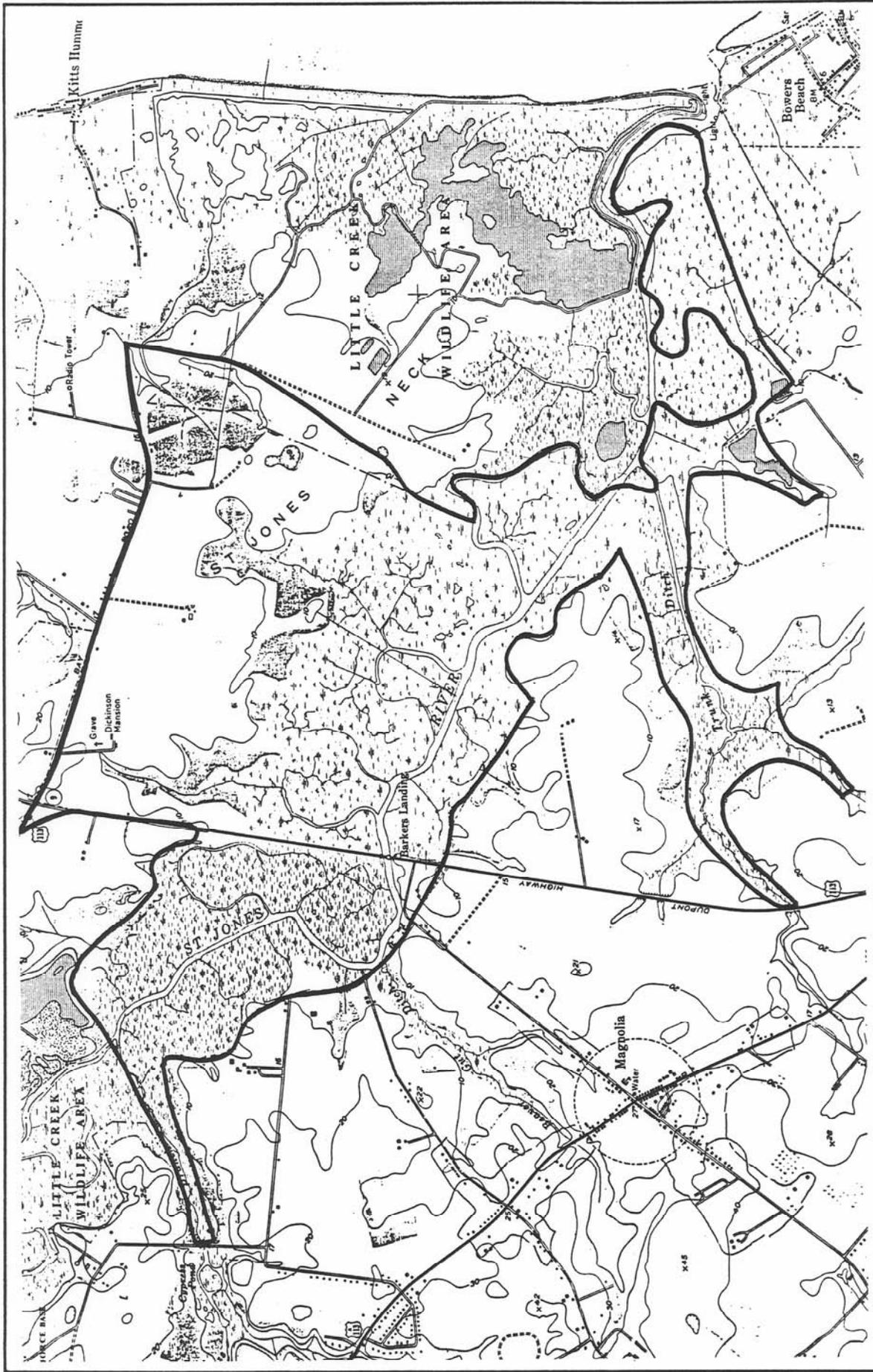


Figure 1. Upper Blackbird Creek DNERR Component
USGS Topographic Map



Wetlands Research Associates, Inc.



**Figure 2. Lower St. Jones River DNERR Component
USGS Topographic Map**



Wetlands Research Associates, Inc.

Phase II of the project followed the Phase I studies conducted in 1994. A vegetation survey of each estuary was conducted, along with some water quality studies. Color-coded maps were completed of the dominant vegetation along each waterway.

There were three major components of the project:

- **Management/oversight**
- **Fish and aquatic macroinvertebrate community studies**
- **Avian community studies with emphasis on waterbirds**

Project management

WRA managed the project, which involved conducting occasional meetings between WRA, Environmental Consulting Services, Inc, and the State of Delaware to discuss logistical issues, establishing a contract agreement with the subcontractor (Environmental Consulting Services, Inc.), monitoring progress of the field work for waterbird surveys and the fish and aquatic macroinvertebrate sampling, producing the progress reports, and resolving billing issues.

Fish and Aquatic macroinvertebrate community studies

Environmental Consulting Services, Inc. (ECSI) of Middletown, DE was the subcontractor to conduct all phases of the fish and aquatic macroinvertebrate work. The field sampling, laboratory processing, and related compilation of the results were done by ECSI personnel with the assistance of two interns. ECSI also contributed data and a narrative describing their work to the reports.

Avian community studies

WRA conducted all phases of the avian survey work. The field surveys were conducted in most cases with the assistance of one or both interns.

Objectives, materials and methods of Phase II, 1994-95

The primary objective of Phase II characterization is to initiate estuarine characterizations through the surveying of finfish, aquatic macroinvertebrates, and waterbirds of the two estuary reserve sites. This characterization work will serve as a baseline for long-term DNERR monitoring activities. During the next few years of the program (Phases III and IV), it is anticipated that subsequent characterization phases will focus on water quality, hydrography, and land use/watershed relations. In keeping with program objectives of both education and research, an agreement was made to employ two interns from Wesley College, Dover DE to assist in the summer fieldwork portion of Phase II activity.

Start up/orientation

Ms. Cris Winters and Dr. Kurt Philipp of Wetlands Research Associates (WRA) worked with the two Wesley interns, Hilary Moore and Amber Moore, and their advisor, Dr. Terry Higgins. During their internship, the Wesley students were also seasonal employees of Environmental Consulting Services Inc.(ECSI) and supervised by Alvin Maiden and Joe Schmidt. Dr. William Meredith of the Delaware Division of Fish and Wildlife, also the DNERR Research Coordinator, provided overall project guidance and review. Field activities began on May 19, 1994 with a general overview of the project goals and sampling procedures.

Facilities and equipment were provided throughout the field data collection period by ECSI and WRA. Access points to open water for sampling by boat and to areas for foot surveys were through public access points and over private property as approved by local landowners.

Finfish community

Study area stratification

The finfish communities of the upper Blackbird Creek and lower St. Jones River were characterized within the five major estuarine community habitats specified in the Department's Scope of Services as they were available in the study areas. They were:

Near-shore Delaware Bay

Beach-front Delaware Bay

Estuarine Channel

Tidal river - channels and edges

Secondary tidal creeks and guts - channels and edges

Tertiary small channels and ditches

Permanent Tidal Pools and Pannes

Emergent Cover Along Tidal River and Creeks

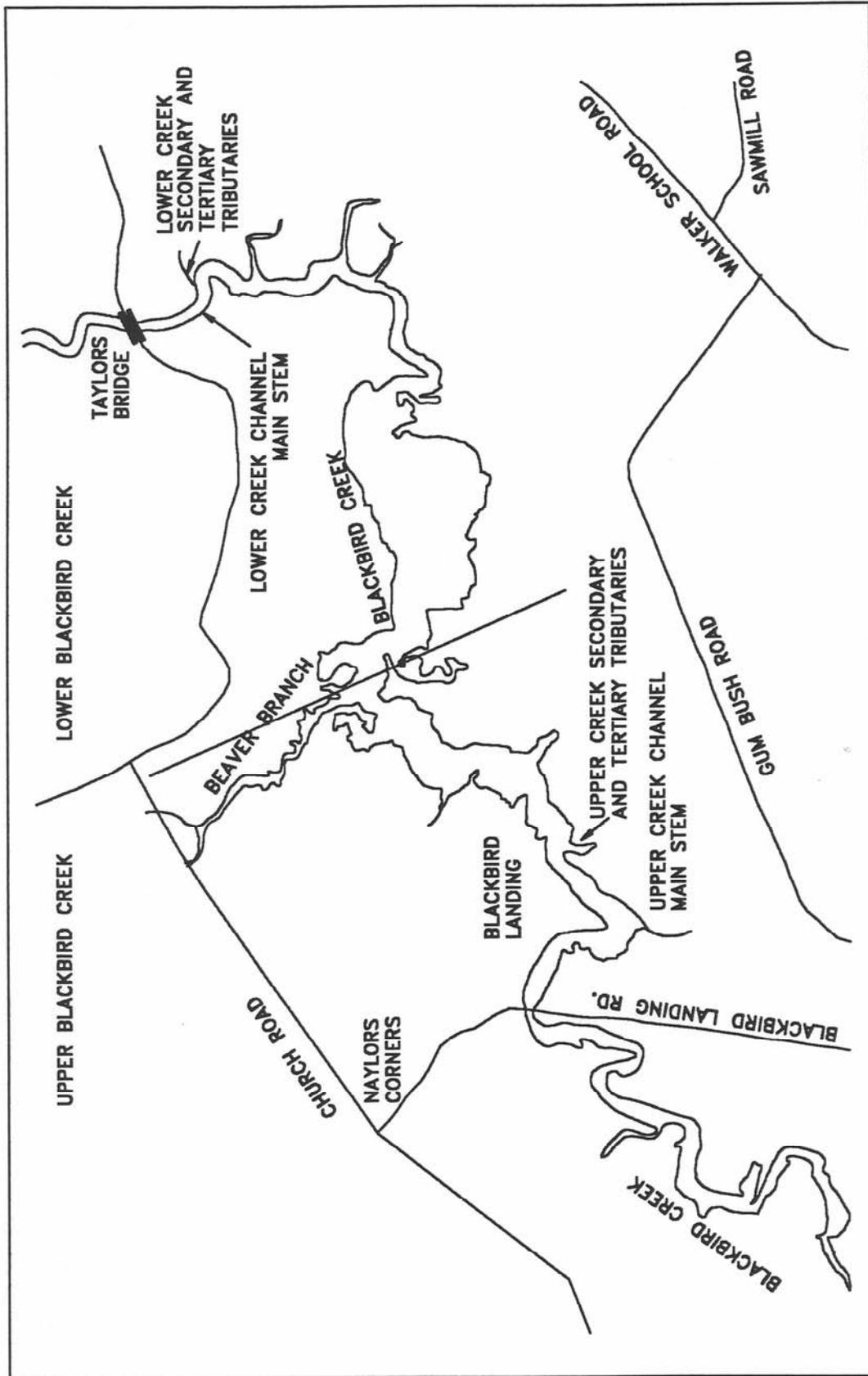
The following are site-specific descriptions of study area stratification. Emergent Cover is not included in the descriptions below as it is all inclusive and present in the other substrata.

Upper Blackbird Creek

The upper Blackbird Creek study area had no **Near-shore** or **Beach-front Delaware Bay** habitats. The **Estuarine Channel** was divided into two roughly equal creek ranges within which all other major community habitats and sub-habitats were sampled (Figure 3). The upstream or upper range included that portion of the creek from the bridge at Blackbird Landing Road to Beaver Branch, and the downstream or lower range included from Beaver Branch to Route 9 bridge at Taylors Bridge. This sub-division into two ranges was intended to address potential community differences related to the absence or presence of salinity in the aquatic environment. The upper range was expected to be freshwater throughout the year, and the lower range was expected to have brackish conditions in the summer and fall. These sub-divisions were made without the benefit of comprehensive historical salinity data. However, data collected by Shirey (1991) in 1986 support this general premise. Sampling locations were chosen to best reflect these likely conditions and community characteristics.

The **Estuarine Channel** was further sub-divided into **Tidal river**, **Secondary tidal gut**, **Tertiary ditch**, **Permanent tidal pool** sub-strata. Each of these sub-strata was represented in each of the two **Estuarine Channel** creek ranges described above. The **Tidal river** sub-stratum was established in the mainstem of the Blackbird Creek. The water depth in the upper range ranged from 0.6 to 1.5 m (tidal amplitude = 0.6m), and main channel stream width was from 10 to 15 m (tidal amplitude = 0.9m). In the lower range water depth ranged from 6 to 9 m, and stream width was from 20 to 30 m.

The **Secondary gut** sub-stratum was established in the next order tributary which was suitably sized to allow the effective deployment of the collection gear, and was



<p>DNERR Site Description Phase II Characterization</p>	<p>Finfish sampling locations in the upper Blackbird Creek portion of the DNERR site.</p> <p>Figure 3</p> <p>ENVIRONMENTAL CONSULTING SERVICES INC.</p>
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sufficiently distant from the other gut sampling location to allow for maximum diversity between the creek ranges. Practically, there were only two guts that were suitably large enough to fish the gear, and were sufficiently distant to yield representative data (Figure 3). The water depth in the upper **Secondary gut** ranged to 0.75 m, and stream width was from 1 to 3 m. In the lower **Secondary gut** water depth ranged to 1 m, and stream width was from 1 to 2 m.

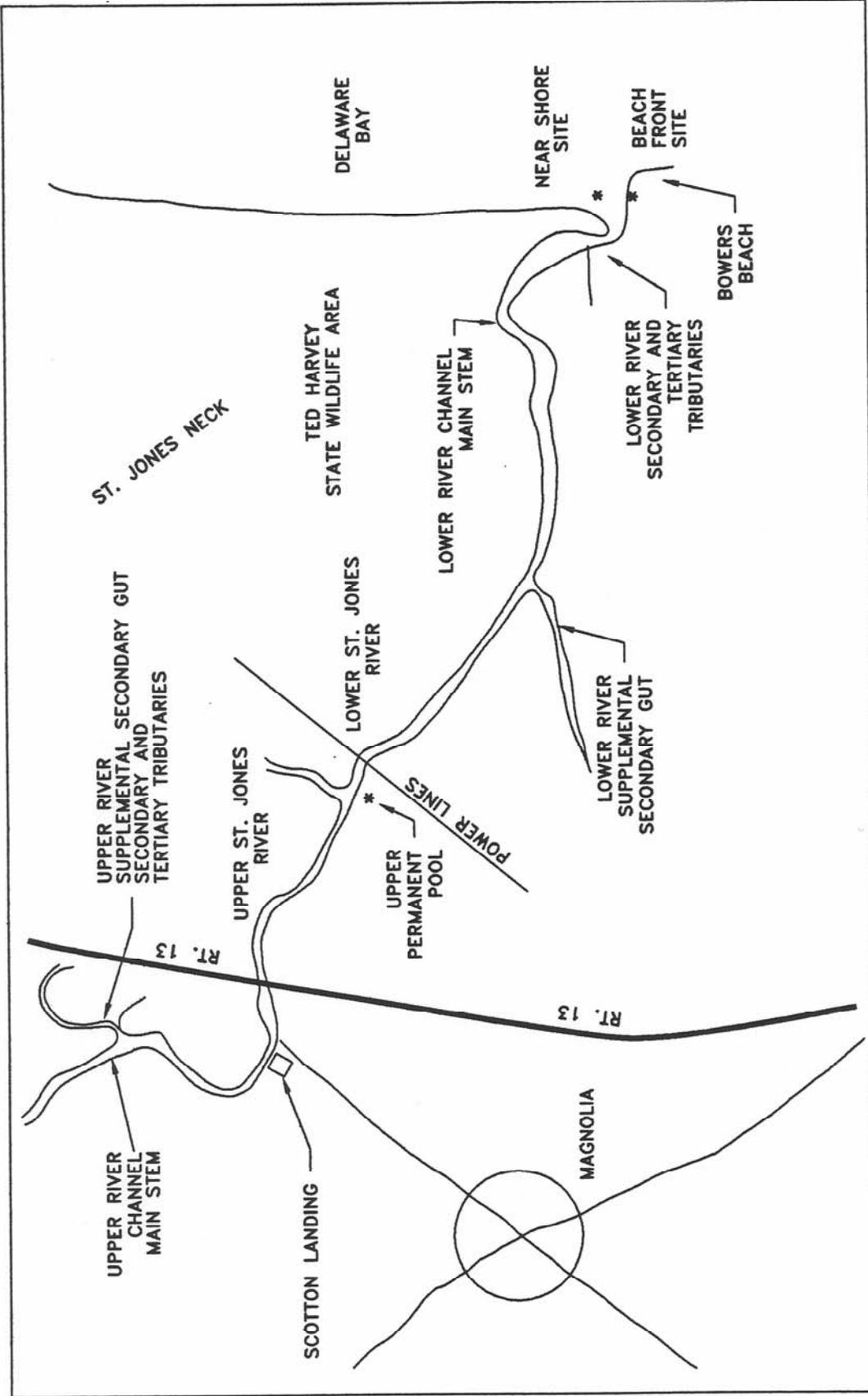
The **Tertiary ditch** sub-stratum was established in the next order tributary within **Secondary gut** previously selected and was suitably sized to allow the effective deployment of the collection gear (Figure 3). The water depth in the upper **Tertiary ditch** ranged to 15 cm, and stream width was from 8 to 15 cm. In the lower **Tertiary ditch** water depth ranged to 15 cm, and stream width was from 8 to 15 cm.

The **Permanent pool** sub-stratum was established at the closest available location to the respective **Tertiary ditch** sampling location. Practically, pools or pannes were not readily available and the distance from the ditch location was as great as a 400 m. The water depth in the upper **Permanent pool** ranged to 8 cm, and the wetted area was approximately 2.5 m². In the lower **Permanent pool** water depth ranged to 8 cm, and the wetted area was approximately 2.5 m².

Lower St. Jones River

The **Near-shore Delaware Bay** habitat off the lower St. Jones River included the channel waters at the confluence of the river and bay (Figure 4). As originally proposed, up- and downbay sub-areas were to be sampled. However, the onsite channel configuration only allowed a single location. To compensate for the lost sub-area, the single location was sampled on consecutive days to improve detection of the representative diversity. The water depth at this location was 1.5-3 m. The **Beach-front** habitat included the littoral and intertidal zones at a site on the Bowers Beach side of the river's mouth.

The **Estuarine Channel** was divided into two roughly equal river ranges within which all other major community habitats and sub-habitats were sampled (Figure 4). The upstream or upper range included that portion of the river from the bridge at Cypress Pond to electric power transmission lines approximately 1.2 km downstream of the Route 113 bridge at Scotton Landing, and the downstream or lower range included from power lines below the Route 113 bridge to the mouth of the river. This sub-division into two ranges was intended to address potential community differences related to absence or presence of salinity in the aquatic environment. Again, these sub-divisions were made without the benefit of comprehensive historical salinity data. However, Shirey (1991) recorded in 1986 salinity as high as 7.8 ppt in the upper St. Jones River at the Route 10 bridge, suggesting that brackish to mesohaline conditions may be found throughout the river to its confluence with the Delaware Bay, where summer salinities might range from 17-23ppt. Sampling locations were chosen to best reflect these likely conditions and community characteristics.



DNERR Site Description
Phase II Characterization

Finfish sampling locations in the lower St. Jones River portion of the DNERR site.

Figure 4

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The **Estuarine Channel** was further sub-divided into **Tidal river**, **Secondary tidal gut**, **Tertiary ditch**, **Permanent tidal pool** sub-strata. Each of these sub-strata was represented in each of the two **Estuarine Channel** river ranges described above. The **Tidal river** sub-stratum was established in the mainstem of the lower St. Jones River. The water depth in the upper range ranged from 3 to 6 m, and stream width was from 25 to 35 m (tidal amplitude = 0.9 m). In the lower range water depth ranged from 8 to 10 m, and stream width was from 50 to 75 m (tidal amplitude = 1.0 m).

The **Secondary gut** sub-stratum was established in the next order tributary that was suitably sized to allow the effective deployment of the collection gear, and was sufficiently distant from the other gut sampling location to allow for maximum diversity between the river ranges. Practically, the selection of the two gut locations was based totally on their suitability for the sampling gear (Figure 4). The relative tributary order from the mainstem was considered biologically unimportant compared to quantity of available habitat as reflected in water depth and stream width. Therefore, **Secondary gut** sub-strata were established in "tertiary ditches" that were small enough to allow deployment of the collection equipment. In both the upper and lower river ranges, the connecting (upper) or most proximal (lower) "secondary guts" were sampled supplementally with the appropriate gear to maintain the continuity of the tributary drainage. The water depth in the upper **Secondary gut** ranged to 0.75 m, and stream width was from 1 to 3 m. In the lower **Secondary gut** water depth ranged to 1 m, and stream width was from 1.5 to 3 m.

The **Tertiary ditch** sub-strata initially were established in the next order tributary within **Secondary gut** previously selected and were suitably sized to allow the effective deployment of the collection gear (Figure 4). However, during the course of the study

these ditches collapsed and slumped onto themselves requiring relocation of the sampling sub-area. Alternative locations were chosen and were less than 100 yards from the original sites. The water depth in the upper **Tertiary ditch** ranged from to 15 cm, and stream width was from 30 to 60 cm. In the lower **Tertiary ditch** water depth ranged to 15 cm, and stream width was from 15 to 50 cm.

The **Permanent pool** sub-stratum was established at the closest available location to the respective **Tertiary ditch** sampling location. As was the case in the Blackbird Creek study area, pools or pannes were not readily available. None were found in the lower river range, and therefore, none were sampled. In the upper river range the only available pool was 400 m from the ditch location just upstream of the power lines. The water depth in the upper **Permanent pool** ranged from 30 to 50 cm, and the wetted area was approximately 15 m².

Sample size and frequency

The finfish communities in the Blackbird and St. Jones study areas were sampled on a quarterly basis during the summer and fall of 1994 and during the spring of 1995. One set of samples with the appropriate collection gear (to be discussed subsequently) was taken in each range within primary, secondary, and tertiary community habitat types during the fall and spring quarters. During the summer quarter two sets of samples were taken. The collection locations within habitats were fixed, and were revisited each quarter to describe any seasonal community characteristics.

Collection gear and implementation

Demersal finfish communities of the Near-shore Delaware Bay and Estuarine Channels/Tidal River, as they were sub-divided in each reserve site, were sampled using a 9-ft semi-balloon trawl towed at 4.4 ft/sec for five minutes in the direction of the tidal flow by a 16-ft research vessel powered by a 25-hp outboard motor. The trawl was deployed using a 6:1 topline to water depth ratio, and boat speed was measured with a Mead Model HP-302 current meter. The 9-ft trawl was manufactured of nylon netting of the following mesh and thread sizes: 1½-in No. 9 body, 1¼-in No. 15 bag, and ½-in No. 63 inner liner. The trawl was fitted with 16- x 10-in doors and a ¾-in topline.

The Beach-front Delaware Bay, Secondary gut, Tertiary ditches, and Permanent pools were sampled with the appropriately sized and practically fishable seine, channel net, blocking net, and/or throw traps. The **Beach-front Delaware Bay** at the St. Jones River was sampled with a 25-ft x 4-ft x ¼-in mesh bag seine deployed perpendicular to the shore and swept radially onto the beach. The topography of the sampling location presented limited seineable area. Therefore, a single sweep was done on each of two field days of the sampling event at the St. Jones River reserve site.

At the **Secondary gut** and **Tertiary ditch** locations, the channel and blocking nets similar to those described by Clark (1991, 1992, 1993) were used to collect samples. A 4- x 4-ft channel net with 5- x 10-ft wings and ¼-in mesh was used at the **Secondary gut** locations. A 25-ft x 4-ft x ¼-in mesh bag seine deployed as a stacked or anchored blocking net was used at the **Tertiary ditch** locations to collect samples. At both locations the appropriate net was stacked or anchored in position at high slack tide, and

fished until low slack tide or when the net was fully exposed by the receding tide. The gear deployment and retrieval times were recorded.

In the **Permanent pools** in the Blackbird Creek study area, a throw trap/quadrant with 0.5 m² surface area was used to collect samples. The throw trap was comprised of two hoops, the upper fitted with flotation and lower weighted, between which a ¼-in mesh net was laced. At the pools the trap was thrown once from a distance of approximately 4.5 m to avoid alerting the target organisms. In the **Permanent pools** in the St. Jones study area, the 25-ft bag seine, as described above, was swept across the pool essentially and effectively sampling the entire pool area. The **Emergent Cover** was not sampled actively. However, observations made as to the occurrence of subject communities were recorded.

Sample processing

Finfishes collected in all gears and in all sub-strata locations were counted and identified typically to species in the field. A subsample of up to 50 individuals were measured to the nearest 5-mm to evaluate age composition and habitat utilization. Blue crabs and other larger invertebrates were also noted. With each collection water temperature, dissolved oxygen, and salinity were measured in the field. Water temperature and dissolved oxygen were measured using the YSI Model 51A or 51B Oxygen Meter giving $\pm 0.5^{\circ}\text{C}$ with 1.0° graduations and giving ± 0.1 mg/l with 0.2 mg/l graduations, respectively. Salinity was measured using the YSI Model 33 S-C-T Meter giving ± 0.5 ppt with 1.0 ppt graduations.

Aquatic macroinvertebrate community

Study area stratification

The aquatic macroinvertebrate communities of the upper Blackbird Creek and lower St. Jones River were characterized within three of the five major estuary community habitats specified in the Department's Scope of Services as they were available and could be sampled in the study areas. They were:

Near-shore Delaware Bay

Estuarine Channel

Tidal river - channels and edges

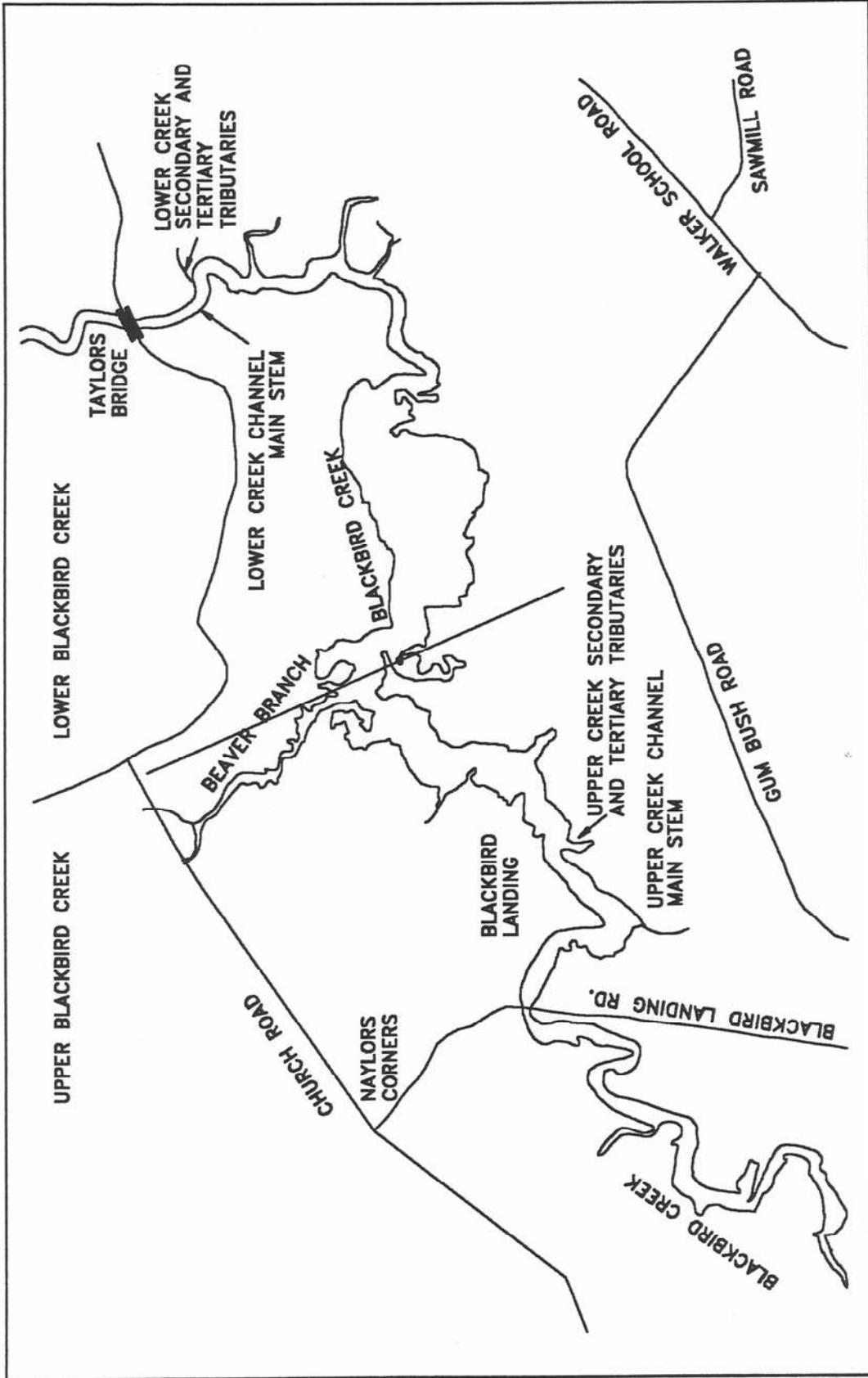
Secondary tidal creeks and guts - channels and edges

Emergent Cover Along Tidal River and Creeks

The omission of some habitat types was related to the physical characteristics of an area and the suitability of the collection gear under those conditions and will be discussed below. The following are site-specific descriptions of study area stratification as it was sampled.

Upper Blackbird Creek

The upper Blackbird Creek study area had no **Near-shore** or **Beach-front Delaware Bay** habitats. The **Estuarine Channel** was divided into two roughly equal creek ranges within which all other major community habitats and sub-habitats were sampled (Figure 5). The upstream or upper range included that portion of the creek from the bridge at



DNERR Site Description
Phase II Characterization

Macroinvertebrate sampling locations in the upper Blackbird Creek portion of the DNERR site.

Figure 5

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Blackbird Landing Road to Beaver Branch, and the downstream or lower range included from Beaver Branch to Route 9 bridge at Taylors Bridge. This sub-division into two ranges was intended to address potential community differences related to the absence or presence of salinity in the aquatic environment. The upper range was expected to be freshwater throughout the year, and the lower range was expected to have brackish conditions in the summer and fall. These sub-divisions will be made without the benefit of comprehensive historical salinity data. However, data collected by Shirey (1991) in 1986 support this general premise. Sampling locations were chosen to best reflect these likely conditions and community characteristics.

The **Estuarine Channel** was further sub-divided into **Tidal river** and **Secondary tidal gut** sub-strata. Each of these sub-strata was represented in each of the two **Estuarine Channel** creek ranges described above. Infaunal aquatic macroinvertebrates were sampled in both the **Tidal river** and **Secondary tidal gut** sub-strata. However, the parabenthic macroinvertebrates were sampled only in the **Tidal river**, because the plankton gear could not be deployed in the relatively small shallow **Secondary tidal gut** sub-strata. The **Tidal river** sub-stratum was established in the mainstem of Blackbird Creek. The water depth in the upper range ranged from 0.6 to 1.5 m (tidal amplitude = 0.6 m), and stream width was from 10 to 15 m (tidal amplitude = 0.9 m). In the lower range water depth ranged from 6 to 9 m, and stream width was from 20 to 30 m.

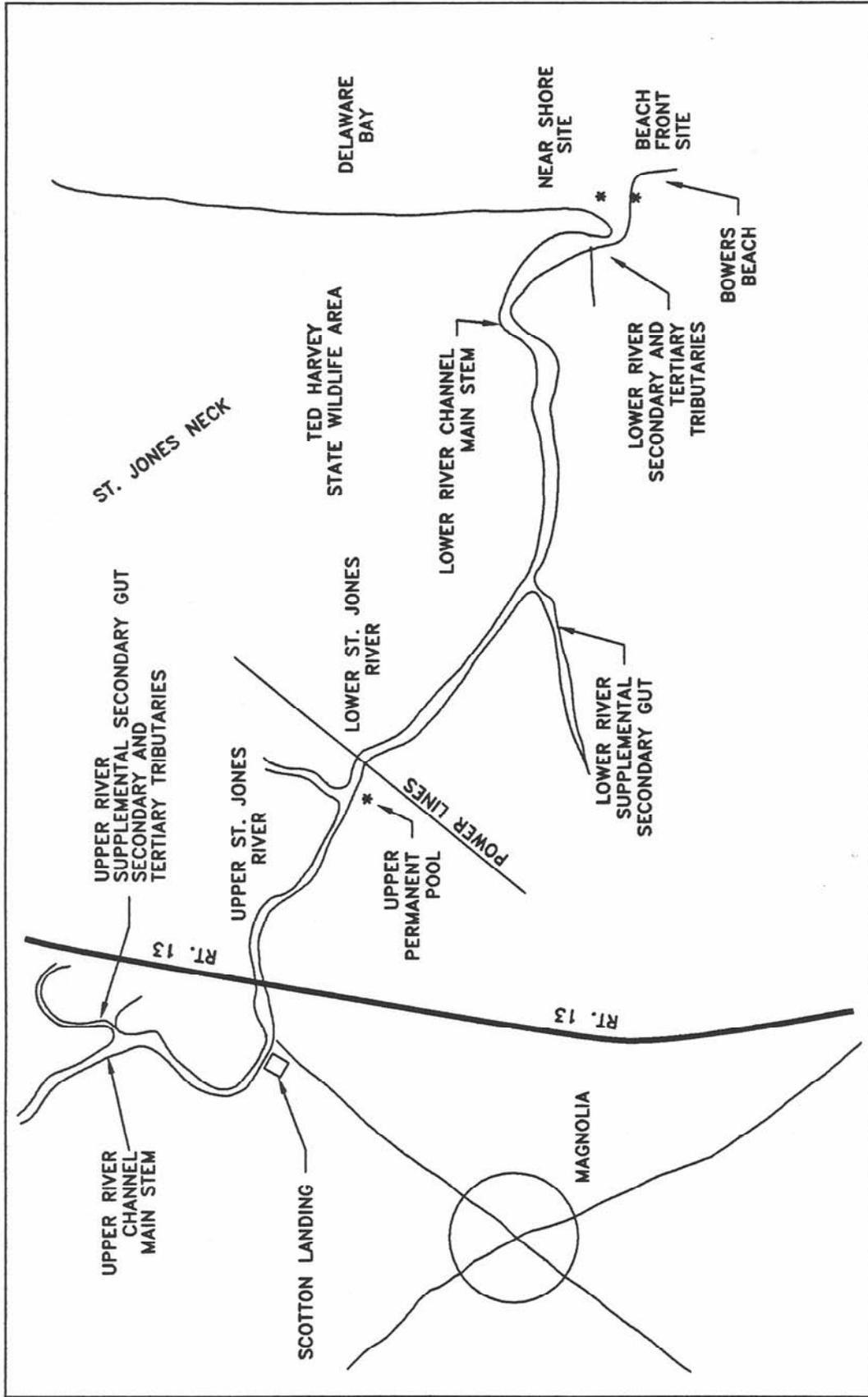
The **Secondary gut** sub-stratum was established in the next order tributary, which was suitably sized to allow the effective deployment of the collection gear, and was sufficiently distant from the other gut sampling location to allow for maximum diversity between the river ranges. Practically, there were only two guts that were suitably large enough to fish the gear, and were sufficiently distant to yield representative aquatic

macroinvertebrate data (Figure 5). The water depth in the upper **Secondary gut** ranged from to 0.75 m, and stream width was from 1 to 3 m. In the lower **Secondary gut** water depth ranged from to 1 m, and stream width was from 1 to 2 m.

Lower St. Jones River

The **Near-shore Delaware Bay** habitat off the lower St. Jones River included the channel waters at the confluence of the river and bay (Figure 6). As originally proposed, up- and downbay sub-areas were to be sampled. However, the onsite channel configuration only allowed a single location. To compensate for the lost sub-area, the samples at the single location were replicated to improve detection of the representative diversity. The water depth at this location was 1-3 meters.

The **Estuarine Channel** was divided into two roughly equal river ranges, within which all other major community habitats and sub-habitats were sampled (Figure 6). The upstream or upper range included that portion of the river from the bridge at Cypress Pond to electric power transmission lines approximately $\frac{3}{4}$ mile downstream of the Route 113 bridge at Scotton Landing, and the downstream or lower range included from the power lines below the Route 113 bridge to the mouth of the river. This sub-division into two ranges was intended to address potential community differences related to the absence or presence of salinity in the aquatic environment. Again, these sub-divisions were made without the benefit of comprehensive historical salinity data. However, Shirey (1991) recorded salinity as high as 7.8 ppt in the upper St. Jones River at the Route 10 bridge in 1986, suggesting that brackish to mesohaline conditions may be found throughout the river to its confluence with Delaware Bay, where summer salinities



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Macroinvertebrate sampling locations in the lower St. Jones River portion of the DNERR site.

Figure 6

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might range from 17-23 ppt. Sampling locations were chosen to best reflect these likely conditions and community characteristics.

The **Estuarine Channel** was further sub-divided into **Tidal river** and **Secondary tidal gut** sub-strata. Each of these sub-strata was represented in each of the two **Estuarine Channel** river ranges described above. Infaunal aquatic macroinvertebrates were sampled in both the **Tidal river** and **Secondary tidal gut** sub-strata. However, the parabenthic macroinvertebrates were sampled only in the **Tidal river**, because the plankton gear could not be deployed in the relatively small shallow **Secondary tidal gut** sub-strata. The **Tidal river** sub-stratum was established in the mainstem of the lower **St. Jones River**. The water depth in the upper range ranged from 3 to 6 m, and stream width was from 25 to 35 m (tidal amplitude = 0.9 m). In the lower range water depth ranged from 8 to 10 m, and stream width was from 50 to 75 m (tidal amplitude = 1.0 m).

The **Secondary gut** sub-stratum was established in the next order tributary that was suitably sized to allow the effective deployment of the collection gear, and was sufficiently distant from the other gut sampling location to allow for maximum diversity between the river ranges. Practically, the selection of the two gut locations was based totally on their suitability for the finfish sampling gear (Figure 6). The relative tributary order from the mainstem was considered biologically unimportant compared to having coincident finfish and aquatic macroinvertebrate samples, as they may reflect potential community interactions. Therefore, **Secondary gut** sub-strata were established in "tertiary ditches" that were small enough to allow deployment the finfish collection equipment, and the infaunal aquatic macroinvertebrate sample was also taken there. As was the case with finfishes, the connecting (upper) and most proximal (lower)

"secondary guts" were sampled for both infaunal and parabenthic aquatic macroinvertebrates with the appropriate gear to maintain the continuity of sampling methods within the tributary drainage. The water depth in the upper Secondary gut ranged to 0.75 m, and stream width was from 1 to 3 m. In the lower Secondary gut water depth ranged to 1.25 m, and stream width was from 2 to 4 m.

Sample size and frequency

The aquatic macroinvertebrate communities in the Blackbird and St. Jones study areas were sampled on a quarterly basis during the summer and fall of 1994 and during the spring of 1995. One set of samples with the appropriate collection gear (to be discussed subsequently) were taken in each range within primary, secondary, and tertiary community habitat types during the fall and spring quarters. During the summer quarter, two sets of samples were taken. As it pertains to infaunal aquatic macroinvertebrates, each "set" included replicates (two collections) within each habitat sampled. For parabenthic macroinvertebrates, each "set" included only a single collection within each habitat sampled. The collection locations within habitats were fixed, and were revisited each quarter to describe any seasonal community characteristics.

Collection gear and implementation

Aquatic macroinvertebrate communities were sampled with a Petite Ponar™ grab sampler (Wildco Supply Company) to characterize the benthic infauna, and a 0.5-m conical plankton net with 0.5-mm mesh to characterize the parabenthos. The grab

sampler was 15- x 15-cm, sampling a square area of 0.023 m². As previously mentioned, the infaunal aquatic macroinvertebrates were not sampled in the **Tertiary ditches** or **Permanent pools**. In the **Tertiary ditches**, the pervasive presence of marsh plant roots rendered the grab sampler inoperative as it became jammed and would not close. Losing this capability, the judgement was made to reallocate infaunal sampling effort from both **Tertiary ditches** and **Permanent pools** to the continuous habitats in the form of sample replication. Sample replication would and did produce better quantitative estimates within the four habitat types in which it was used, and actually resulted in the collection of more samples than were originally specified.

The plankton net used to collect parabenthic macroinvertebrates was equipped with a General Oceanics flowmeter to measure the volume of water sampled, and a 5-kg depressor to achieve sub-surface sampling depths. The plankton net was deployed in step-wise oblique manner in sampling sub-strata where the water depth was >5 feet, and at or near the surface where the depth was <5 feet. Sample tow duration was three minutes. All aquatic macroinvertebrate samples from grab and net collections were preserved in the field in a 10 percent buffered formalin/rose bengal solution. With each biotic collection, water temperature, dissolved oxygen, and salinity were measured in the field. The equipment used was as described in the finfish community sampling methods.

Sample Processing

Ponar™ and plankton net samples were washed in the laboratory to remove the fixative and the finer fraction of sediment or detritus using a 0.5-mm mesh sieve. The contents of the sieve were poured to a glass tray, placed over a light-table, and the aquatic macroinvertebrates were removed from the coarser fractions of sediment and detritus.

Specimens were counted and identified to the lowest practical taxonomic level. The lowest level or the "operational taxonomic unit" (OTU) varied depending on specimen condition, availability of reference literature, and time. The OTU was genus or species for most taxa, but for the smaller, more subtle types such as chironomids, oligochaetes, and nemertean, the OTU ranged from family to phyla. Some taxa present in the parabenthic macroinvertebrate samples, (such as jellyfish and comb jellies) that tended to disintegrate after preservation with formalin, were noted as present but not counted. Other taxa which are not considered as part of the aquatic macroinvertebrate fauna, such as the zoea and megalopa life stages of brachyuran crabs (size less than 500 microns), were also noted.

Avian communities

Sampling areas

Similar methods and materials were used for the Blackbird Creek and St. Jones River surveys. Initial reconnaissance was conducted on May 25, 1994 at both the Blackbird Creek and St. Jones River sites. Several observation points were located at each area and a tentative observation point map was produced. This map was subsequently revised as landowners with useful access to potential points were contacted over the next two weeks. The map included with this report is the updated map of observation points used for the waterbird surveys (Figures 7 and 8 and Table 1).

During the first survey at each observation point, information was collected on vegetation types and the geographic limits of observation at each point. During these initial surveys, methods, optimal observation points, and other logistical issues were

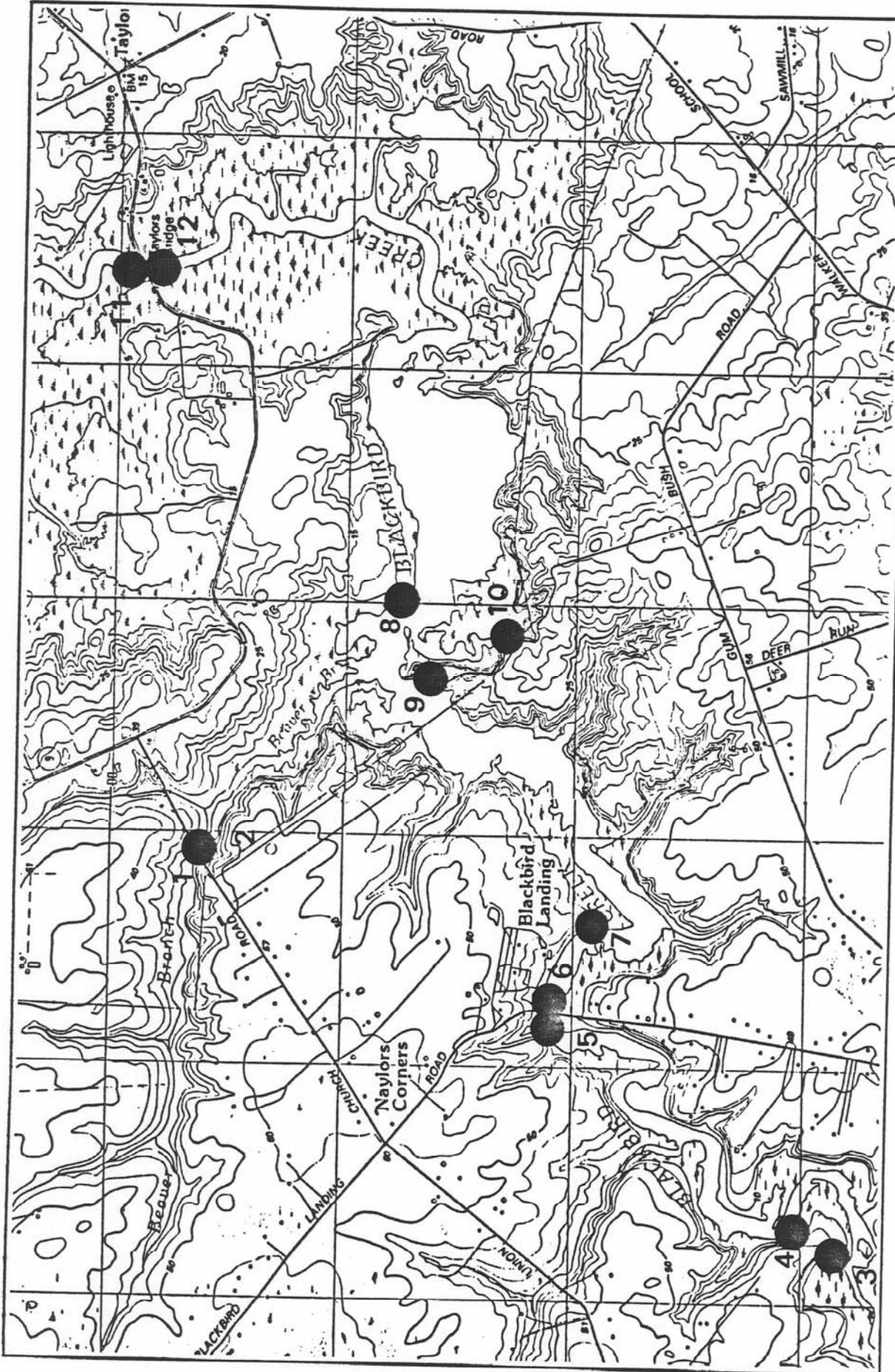


Figure 7. Blackbird Creek DNERR Site
 Water Bird Survey Observation Points
 6/30/94



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adjusted. At each subsequent survey session (Table 1), data on weather conditions and tides were recorded. Observations were conducted for ten minutes at each site and included bird species, life stage and sex (if known), and activity/behavior at the time of observation. Information also recorded included birds observed outside the time period if they were not included in the data, other animals or animal signs observed, and human activity at or near the observation points.

Literature review

The data and literature review was initiated with a discussion with Gene Hess of the Delaware Museum of Natural History and Delmarva Ornithological Society (D.O.S.) of past surveys conducted by birders at either of the two study areas. Although he did not know of formal studies at either of the sites, Mr. Hess suggested checking the indices of the past twenty years of *The Delaware Ornithologist* for references to sections of either of the DNERR sites. No such references were found.

The only reference found was in another D.O.S. publication, entitled *Where to Look for Birds on the Delmarva Peninsula, Monograph No. 2. Wilmington, DE. 1978*. In the section State Route 9, Southward is a portion of a paragraph that refers to the Blackbird Creek area. The description tells of being able to see or hear 10 to 30 species of birds at any time of the day or year with the aid of a screech owl tape. "Besides the usual passerines attracted by the recording, one can expect vultures, buteos, Bobwhite [sic], Screech and Great Horned Owls [sic], and Belted Kingfisher [sic]" (P. 14). This area was also reported to be very good for wintering finches and, during spring migration, for woodcock, flycatchers, vireos, warblers, and other passerines.

Delmarva Ornithological Society Christmas Bird Count

The records from the Christmas Bird Counts (CBCs) conducted by the Delmarva Ornithological Society (D.O.S.) were investigated for possible bird survey information in the DNERR sites or nearby areas. The Christmas Counts are held each year between mid-December and the first week in January. The D.O.S. is responsible for six Counts in Delaware and one in Elkton, MD. Each count is divided into areas that are surveyed along similar routes each year, by car or by foot.

The Middletown Christmas Bird Count (Appendix A) has been conducted since the 1960's. The Blackbird Creek estuary is included in Area 5. Five of the CBC observation points are located along the Blackbird Creek, and three of them correspond to points used in this survey: Observation Points 1 and 2 (Beaver Brook North and South), 5 and 6 (Blackbird Landing East and West), and 11 and 12 (Taylor's Bridge East and West). The fourth CBC observation point is east of and outside the DNERR area at Staves Landing. The fifth is at a road crossing of a tributary to Beaver Brook (or Beaver Branch) just east of DNERR Observation Points 1 and 2.

The Bombay Hook CBC, conducted at some areas since the 1930's, does not actually include any of the DNERR St. Jones site (Appendix A). However, Area 8 does include the upper St. Jones, with one observation point approximately one and one-half miles north west of DNERR Observation Point 1 (Branch Bridge). The habitat at this point is very similar to that of the upper DNERR survey area, the rest of the CBC including much suburban and urban observation points until much farther upstream from the DNERR area.

For several reasons, the CBC data cannot be directly compared with the DNERR survey data. The CBC data is recorded by area, not by observation point. Therefore, the data from the Middletown CBC Area 5, for example, has three observation points common to the DNERR Survey as well as data from all other points in Area 5.

In addition, the CBCs are conducted for an entire day with unlimited observations by a variable number of observers at each observation point. Observation points are quite variable from year to year as well, usually being points at which the observer stops to see interesting-looking birds.

Because of the abundance of CBC data available from at least the past thirty years, it is valuable for observing bird occurrences and population trends in wintering birds. It may be possible in the future to incorporate or add DNERR Observation Points and some standardized data collection methods to the appropriate CBCs in order to strengthen the DNERR data base.

Delaware Natural Heritage Inventory Program

The Delaware Natural Heritage Inventory (NHI) Program collects information on plant and animals species of concern in the state (nearly every state has a NHI Program) (Appendix B). This information is stored on an Element Occurrence Record (EOR) for each siting of each individual or population in a given location. Each location is then mapped on USGS Topographic Quadrangle maps and coded to correspond to the appropriate EOR. A recent review of the EOR location maps at the Delaware NHI program office turned up several records of birds of state concern in each of the DNERR sites: five records in DNERR - St. Jones River and two in DNERR - Blackbird Creek.

These are outlined in the following table.

DE NHI Element Occurrence Records for Birds in the DNERR			
Bird Species	NHI Status	Blackbird Creek	St. Jones River
Bald Eagle	S1B, S2N	EOR at same nest site as observed at DNERR Survey - Obs. Pt. 8 (Harvey Farm).	EOR northwest of Obs. Pt. 1 (Branch Bridge). Not observed in DNERR Survey.
Black Skimmer	S1B	-	EOR at Bowers Beach. Observed at DNERR Survey Obs. Pt. 11 (Bowers Bch).
Black-necked Stilt	S2B	-	EOR at Bowers Beach. Not observed in DNERR Survey.
Least Tern	S1B	-	EOR at Bowers Beach. Observed at DNERR Survey Obs. Pt. 11 (Bowers Bch).
Northern Harrier	S1B, S4H	EOR east of Taylors Bridge. Observed at DNERR Obs. Pt. 11 (Taylors Bridge N).	EOR north of St. Jones River. Observed at DNERR Obs. Pts. 4/5 (Boardwalk E & W).

The NHI Element Occurrence Records above are for birds observed at a nest, with new young or exhibiting nesting behavior (confirmed breeding) or at the site during nesting season (therefore probably breeding). Four out of five of the EOR birds were observed during the DNERR Survey, although not always at the same season, reinforcing each program.

In addition to the Element Occurrence Record data, the NHI Program conducts and publishes reports on biological and natural community studies and surveys. One such report, *Biological and Natural Community Analyses of Riparian Communities Within the*

Coastal Zone of Kent County, Delaware (February 1995), includes some general data from the St. Jones watershed, including the DNERR site. The zoological inventory discusses the importance of the St. Jones watershed as a feeding area for resident and migratory waterbirds, including Great Egret, Snowy Egret, and Northern Harrier and as a nesting area for the Coastal Plain Swamp Sparrow. The present habitat quality is described, as well as threats to the significant areas within the watershed and the plants and animals, especially waterbirds, they support. Appendix C presents the list of bird species found during the 1994 inventory of the St. Jones River. The DNERR area is not separated out from the body of data and makes up only the brackish to saltwater portion of the watershed.

Delaware DNREC Non-game Program Surveys

Several studies targeting or including waterbirds are conducted by the DNREC Division of Fish and Wildlife Non-game Program. Yearly Shorebird Migration Surveys have been conducted in Delaware since 1982. These surveys include both aerial and ground counts. The aerial counts cover both sides of the Delaware Bay and since 1986 have been conducted jointly with the New Jersey Department of Environmental Protection. The ground surveys are conducted at 13 Delaware beaches from Woodland Beach to Cape Henlopen. As with the other surveys mentioned, the data from these shorebird surveys cannot be directly compared to the DNERR surveys. There are some observation points that are in close proximity to one another (near St. Jones observation point 11 - Bowers Beach and near observation point 10 - Logan Lane Tract Beach) and the data can be used to show trends and species composition.

In addition to the State of Delaware shorebird surveys, there is an International Shorebird Survey conducted by the Manomet Observatory for Conservation Science (Manomet, MA). This survey is much broader in its approach, but it does cover portions of the DNERR sites and may be useful for tracking population trends, timing of site use by shorebirds, and other general issues.

For the past two seasons, Colonial Waterbird Surveys have been conducted by the Non-game Program as part of a larger regional effort to track nesting of such birds. These include species such as the terns, gulls, herons, and egrets. The only confirmed nesting found in this survey that is near a DNERR site is a record of 23 least tern nests found at South Bowers Beach, about one kilometer south of the DNERR St. Jones boundary. Data from the DNERR Surveys may assist the Non-game office in looking at specific areas for possible nesting, such as the many Black Skimmers surveyed at the observation points near the Logan Lane Tract during the breeding season. Also, data from the Colonial Waterbird Surveys will be available to supplement the DNERR Surveys.

Delaware DNREC Aerial Waterfowl Survey

The DNREC Division of Fish and Wildlife has conducted aerial waterfowl surveys since 1974 over the Delaware coastal wetlands, as well as inland from Dover southwest to the Maryland border. The surveys are conducted at mid-month in October, November, December, and January.

The survey data area recorded by Unit. Unit 4 includes the Blackbird Creek estuary, but the unit boundaries extend from Liston Point south to Route 6 and from the Delaware Bay west to Townsend. The St. Jones estuary is included in Unit 6, that extends from

Port Mahon Road south to Big Stone Beach and from the Delaware Bay west to Dover. Much of the data taken in this unit is from the Ted Harvey/Little Creek/Logan Lane Tract Wildlife Management Areas.

As with many of the other waterbird surveys reviewed here, the data are useful for looking at gross trends and species occurrence, but the larger geographic areas from which the data are collected do not allow direct comparison with the DNERR Survey data. Also, the waterfowl survey is conducted only in the fall and winter months, so breeding numbers are not included.

Delaware Gap Analysis Project

The National Biological Survey, U.S. Fish and Wildlife Service, and other agencies are currently conducting a Gap Analysis Project (GAP) in Delaware to identify gaps in the protection of biodiversity. The Blackbird Creek DNERR watershed is being closely examined as part of this project, and bird surveys are a major component of the proposed work. The objectives of the study include habitat modeling to identify suitable habitats for commonly- occurring terrestrial vertebrates and butterflies, accuracy assessment, and mapping of bird migration and overwintering habitats.

At this time, the Land Cover Base Map has been produced and the field work in the DNERR area will begin in February 1996 (An informal bird survey was conducted in the Blackbird State Forest - upstream from the DNERR - Blackbird Creek site - in summer 1995). It is expected that the data will be compiled by spring 1997 and will include an analysis of changes in habitat type since human settlement of the area and resulting changes in bird distribution.

Appendix D presents the sources of information for the above referenced data.

Results and Discussion

Finfish

Upper Blackbird Creek

General species composition and abundance

The upper Blackbird Creek finfish community was represented by 21 species (Table 2). The total number of fish collected from all stations in all seasons was 4892. Four species comprised over 95% of the total catch. In order of decreasing abundance, with the respective percent of the total catch, they were: spot (47%), Atlantic menhaden (25%), white perch (12%), and mummichog (11%). These four species were representative of estuarine resident (white perch and mummichog), and estuarine dependant (spot and Atlantic menhaden) finfish. In general, the greatest number of fish were collected from the secondary tributaries, which represented 92% of the total catch.

Spot, *Leiostomus xanthurus*, represented 47% of the total catch, with 2319 specimens collected. The highest numbers of specimens captured were from the secondary tributaries, that is, the creeks that drain empty at low tide. None were collected from either the tertiary tributaries or tidal pools.

Atlantic menhaden, *Brevoortia tyrannus*, represented 25% of the total catch, with 1241 specimens collected. They were collected almost exclusively from the secondary

Table 2

Summary of fish collected from the upper Blackbird Creek portion of the DNERR area, during 1994 (summer, fall) and 1995 (spring).

Species	Upper Study Area				Lower Study Area				Subtotals	Percent of total	Cumulative Percent of total
	Main	2 ^o	3 ^o	Pools	Main	2 ^o	3 ^o	Pools			
Spot	66	165			49	2039			2319	47.40%	47.40%
Atlantic menhaden		1232	5			4			1241	25.37%	72.77%
White perch	64	118			24	379			585	11.96%	84.73%
Mummichog	1	275	13	15		175	16	28	523	10.69%	95.42%
Hogchoker	5				68	5			78	1.59%	97.02%
Striped bass						36			36	0.74%	97.75%
American eel		1			4	15			20	0.41%	98.16%
Weakfish	1	6			1	11			19	0.39%	98.55%
Atlantic silverside		3				15			18	0.37%	98.92%
Brown bullhead	2					14			16	0.33%	99.24%
Silvery minnow	4	2				13			15	0.31%	99.55%
Black drum	2					1			5	0.10%	99.65%
Channel catfish	2				2				4	0.08%	99.73%
Bay anchovy	1					2			3	0.06%	99.80%
Gizzard shad						3			3	0.06%	99.86%
Yellow perch						2			2	0.04%	99.90%
Black crappie						1			1	0.02%	99.92%
Blueback herring						1			1	0.02%	99.94%
Bluegill		1				1			1	0.02%	99.96%
Inland silverside						1			1	0.02%	99.98%
Pumpkinseed		1				1			1	0.02%	99.98%
Subtotals	146	1804	18	15	148	2717	16	28	4892	= Grandtotal	100.00%

tributaries; none were taken from the main tributaries or tidal pools.

White perch, *Morone americana*, represented almost 12% of the total catch, with 585 specimens collected. The highest numbers of specimens were collected in the secondary tributaries.

Mummichog, *Fundulus heteroclitus*, represented almost 11% of the total catch, with 523 specimens collected. The mummichog was the only finfish species captured from all tributary types, although the majority were collected in the secondary tributaries.

Seasonal characterizations

The total number of finfish collected in upper Blackbird Creek ranged from a minimum of 164 in the spring of 1995, to the seasonal maximum of 4541 in the summer of 1994 (Tables 3 through 5).

Summer

In sixteen samples, 4541 finfish of 15 species were collected in upper Blackbird Creek during the summer of 1994 (Table 3). Four finfish species comprised over 95% of the total. In order of decreasing abundance, these species are listed with their respective percent of the total catch: spot (49%), Atlantic menhaden (27%), mummichog (10%) and white perch (9%). Nearly 94% of the entire finfish sample was captured in the secondary tributaries. The spot and Atlantic menhaden were all young-of-the-year, while the resident mummichog and white perch were of various age classes.

Table 3

Summary of fish collected from the upper Blackbird Creek portion of the DNERR area, during the summer of 1994.

Species	Upper Study Area Sub divisions				Lower Study Area Sub divisions				Subtotals	Percent of total	Cumulative Percent of total
	Main	2 _o	3 _o	Pools	Main	2 _o	3 _o	Pools			
Spot	64	160			46	1935			2205	48.56%	48.56%
Atlantic menhaden		1227	5			4			1236	27.22%	75.78%
Mummichog	1	235		8		175	11	28	458	10.09%	85.86%
White perch	23	98			24	275			420	9.25%	95.11%
Hogchoker	5				51	4			60	1.32%	96.43%
Striped bass						35			35	0.77%	97.20%
Weakfish	1	6			1	11			19	0.42%	97.62%
Atlantic silverside		3				14			17	0.37%	98.00%
American eel					4	4			8	0.18%	98.17%
Brown bullhead						7			7	0.15%	98.33%
Black drum	4					1			5	0.11%	98.44%
Channel catfish	1				2				3	0.07%	98.50%
Yellow perch						2			2	0.04%	98.55%
Bluegill		1							1	0.02%	98.57%
Bay anchovy	1								1	0.02%	98.59%
Subtotals	101	1730	8	8	131	2523	12	28	4541	= Grandtotal	

Fall

In eight samples, 251 finfish of 13 species were collected in upper Blackbird Creek during the fall of 1994 (Table 4). Three species comprised over 90% of the total. In order of decreasing abundance, these species are listed with their respective percent of the total catch: spot (45%), white perch (40%), and silvery minnow (*Hybognathus regius* 5%). Nearly 89% of the entire finfish sample was captured in the secondary tributaries. No specimens were collected from the tidal pools. The spot were all young-of-the-year, while the resident white perch and silvery minnows were of various age classes.

Spring

In eight samples, 164 finfish were collected in upper Blackbird Creek during the spring of 1995 (Table 5). Five finfish species comprised nearly 94% of the total catch. In order of decreasing abundance, these species are listed with their respective percent of the total catch: white perch (39%), mummichog (37%), hogchoker (*Trinectes maculatus* 8%), American eel (*Anguilla rostrata* 6%), and brown bullhead (*Ameiurus nebulosus* 4%). The total catch was more evenly distributed between the primary, secondary, and tertiary tributaries, although the secondary tributary still produced the largest sample of finfish. All of the most abundant fish were of various age classes.

Lower St. Jones River

General species composition and abundance

The lower St. Jones River finfish community was represented by 25 species (Table 6). The total number of specimens collected from all stations in all seasons was 4707. Six species comprised over 94% of the total catch. In order of decreasing abundance, these

Table 4

Summary of fish collected from the upper Blackbird Creek portion of the DNERR area, during the fall of 1994.

Species	Upper Study Area Sub divisions				Lower Study Area Sub divisions				Subtotals	Percent of total	Cumulative Percent of total
	Main	2 _o	3 _o	Pools	Main	2 _o	3 _o	Pools			
Spot	2	5			3	104			114	45.42%	45.42%
White perch	14	15				72			101	40.24%	85.66%
Silvery minnow						12			12	4.78%	90.44%
Hogchoker					5				5	1.99%	92.43%
Mummichog		3	1				1		5	1.99%	94.42%
Atlantic menhaden		5							5	1.99%	96.41%
American eel						2			2	0.80%	97.21%
Brown bullhead	2								2	0.80%	98.01%
Inland silverside						1			1	0.40%	98.41%
Blueback herring						1			1	0.40%	98.80%
Bay anchovy						1			1	0.40%	99.20%
Striped bass						1			1	0.40%	99.60%
Gizzard shad						1			1	0.40%	100.00%
Subtotals	18	28	1	0	8	195	1	0	251	= Grandtotal	

Table 5
 Summary of fish collected from the upper Blackbird Creek portion
 of the DNERR area, during the spring of 1995.

Species	Upper Study Area Sub divisions				Lower Study Area Sub divisions				Subtotals	Percent of total	Cumulative Percent of total
	Main	2.	3.	Pools	Main	2.	3.	Pools			
White perch	27	5				32			64	39.02%	39.02%
Mummichog		37	12	7			4		60	36.59%	75.61%
Hogchoker					12	1			13	7.93%	83.54%
American eel		1				9			10	6.10%	89.63%
Brown bullhead						7			7	4.27%	93.90%
Silvery minnow		2				1			3	1.83%	95.73%
Gizzard shad						2			2	1.22%	96.95%
Atlantic silverside						1			1	0.61%	97.56%
Black crappie						1			1	0.61%	98.17%
Bay anchovy						1			1	0.61%	98.78%
Pumpkinseed		1							1	0.61%	99.39%
Channel catfish	1								1	0.61%	100.00%
Subtotals	28	46	12	7	12	55	4	0	164	= Grandtotal	

Table 6

Summary of fish collected from the lower St. Jones River portion of the DNERR area, during 1994 (summer, fall) and 1995 (spring)

Species	Upper Study Area Sub divisions						Lower Study Area Sub divisions						Bay Study Area						Subtotals	Percent of total	Cumulative Percent of total
	Main		2, gut		3,		Main		2, gut		3,		Inshore		Shorezone						
													Rep 1	Rep 2	Rep 1	Rep 2					
Atlantic silverside			531			5			170						412	80	1198	25.45%	25.45%		
Mummichog		1	155	5	303			670	9								1143	24.28%	49.73%		
Spot	1	127	16				8	67	578			18	13	1			829	17.61%	67.35%		
Sheepshead minnow				2	630			1	1								634	13.47%	80.82%		
White perch	7	106	10				46	30	143			4	11	168	46	281	342	7.27%	88.08%		
Bay anchovy			30					22									65	5.97%	94.05%		
Hogchoker	45	4					7	3				6					51	1.38%	95.43%		
Weakfish	14	17					5	4				7	4				32	1.08%	96.52%		
American eel			3				2	27									31	0.68%	97.20%		
Spotted halke							7	2				22					29	0.66%	97.85%		
Striped bass			1				1	26				1	1				21	0.62%	98.47%		
Black drum			6	1			1	7	6								12	0.45%	98.92%		
Atlantic herring								2						8	2		10	0.25%	99.17%		
Atlantic croaker	9											1					5	0.21%	99.38%		
Silver perch			1	1				2					1				4	0.11%	99.49%		
Channel catfish	4																4	0.08%	99.58%		
Striped killifish								2						2			4	0.08%	99.66%		
Striped mullet			1					3									4	0.08%	99.75%		
Black sea bass												2					2	0.04%	99.79%		
Bluefish								2									2	0.04%	99.83%		
Inland silverside			2														2	0.04%	99.87%		
Northern searobin												2					2	0.04%	99.92%		
Oyster toadfish												2					2	0.04%	99.96%		
Banded killifish			1														1	0.02%	99.98%		
Summer flounder												1					1	0.02%	100.00%		
Subtotals	80	262	752	7	938		76	113	1654	10		66	30	591	128	4707	= Grandtotal				

species are listed with their respective percent of the total catch: Atlantic silverside (25%), mummichog (24%), spot (18%), sheepshead minnow (13%), white perch (7%), and bay anchovy (6%). These six species are typical estuarine species, able to tolerate a wide range of salinities. They included five estuarine resident species (Atlantic silverside, mummichog, sheepshead minnow, white perch, and bay anchovy), and one estuarine dependant species (spot). In general, the greatest number of specimens were collected from the secondary tributaries.

Atlantic silverside, *Menidia menidia*, represented 25% of the total catch, with 1198 specimens collected. The greatest numbers were collected in samples taken from the secondary tributaries and shorezone areas.

Mummichog, represented 24% of the total catch, with 1143 specimens collected. They were collected almost exclusively from samples taken in the secondary tributaries and permanent pools.

Spot, represented 18% of the total catch, with 829 specimens collected. They were taken primarily in samples collected within the secondary tributaries.

Sheepshead minnow, *Cyprinodon variegatus*, represented 13% of the total catch, with 634 specimens collected. They were taken almost exclusively from samples collected from the permanent pools.

White perch, *Morone americana*, represented 7% of the total catch, with 342 specimens collected. They were collected primarily in the secondary tributaries and guts.

Bay anchovy, *Anchoa mitchilli*, represented 6% of the total catch, with 281 specimens collected. They were taken mostly in samples collected in the shorezone habitat.

Seasonal characterizations

The total number of finfish collected in the lower St. Jones River ranged from a minimum of 193 in the spring of 1995, to the seasonal maximum of 3864 in the summer of 1994 (Tables 7 through 9).

Summer

In 28 samples, 3864 finfish of 17 species were collected in the lower St. Jones River during the summer of 1994 (Table 7). Five finfish species comprised nearly 91% of the total catch. In order of decreasing abundance, these species are listed with their percent of total taken: Atlantic silverside (28%), mummichog (28%), spot (19%), sheepshead minnow (9%), and bay anchovy (7%). Nearly 59% of the total finfish catch was collected from the secondary tributaries.

Fall

In 14 samples, 650 finfish of 15 species were collected in the lower St. Jones River during the fall of 1994 (Table 8). Five finfish species comprised over 93% of the total. In order of decreasing abundance, these species are listed with their percent of total taken: sheepshead minnow (45%), white perch (14%), spot (13%), Atlantic silverside (12%), and mummichog (9%). Over half of the finfish catch was collected in the permanent pools, because of the large catch of sheepshead minnow there.

Table 7

Summary of fish collected from the lower St. Jones River portion of the DNERR area, during the summer of 1994.

Species	Upper Study Area						Lower Study Area						Bay Study Area				Subtotals	Percent of total	Cumulative Percent of total
	Sub divisions			Sub divisions			Inshore		Shorezone		Rep 1	Rep 2	Rep 1	Rep 2					
	Main	2.0 gut	2.0	3.0	Pools	Main	2.0 gut	2.0	3.0	Pools									
Atlantic silverside			531									407	76				1090	28.21%	28.21%
Mummichog			129	5	258				5								1063	27.51%	55.72%
Spot	1	53	16			64	578					18	11				742	19.20%	74.92%
Sheepshead minnow				2	335												337	8.72%	83.64%
Bay anchovy			30					22				9	168	46			275	7.12%	90.76%
White perch	3	24	10			3	143										183	4.74%	95.50%
Weakfish	14	17				5	4				7	4					51	1.32%	96.82%
Hogchoker	31	2				2					5						40	1.04%	97.85%
American eel			3					27									30	0.78%	98.63%
Striped bass			1					26					1				28	0.72%	99.35%
Black drum		1	1			2	6										10	0.26%	99.61%
Atlantic croaker	5																5	0.13%	99.74%
Silver perch		1	1					2									4	0.10%	99.84%
Striped killifish												2					2	0.05%	99.90%
Bluefish							2										2	0.05%	99.95%
Oyster toadfish											1						1	0.03%	99.97%
Summer flounder											1						1	0.03%	100.00%
Subtotals	54	98	722	7	593	5	75	1548	5	0	32	25	578	122			3864		= Grandtotal

Table 8

Summary of fish collected from the lower St. Jones River portion of the DNERR area, during the fall of 1994.

Species	Upper Study Area						Lower Study Area						Bay Study Area				Subtotals	Percent of total	Cumulative Percent of total		
	Sub divisions			Sub divisions			Sub divisions			Shorezone			Inshore	Rep 1	Rep 2	Rep 1				Rep 2	
	Main	2o gut	3o	Main	2o gut	3o	Main	2o gut	3o	Pools	Rep 1	Rep 2									Rep 1
Sheepshead minnow																			294	45.23%	45.23%
White perch		41					44	4											89	13.69%	58.92%
Spot		74					8	3						2					87	13.38%	72.31%
Atlantic silverside									69										75	11.54%	83.85%
Mummichog		1	20						1	1									61	9.38%	93.23%
Hogchoker	12						2												14	2.15%	95.38%
Black drum		5					1	5											11	1.69%	97.08%
Atlantic croaker	4														1				5	0.77%	97.85%
Channel catfish	4																		4	0.62%	98.46%
Bay anchovy														3					3	0.46%	98.92%
Striped killifish																			2	0.31%	99.23%
Inland silverside			2																2	0.31%	99.54%
Banded killifish			1																1	0.15%	99.69%
Silver perch																		1	1	0.15%	99.85%
Spotted hake							1												1	0.15%	100.00%
Subtotals	20	121	23	0	335	0	56	12	72	1	0	4	3	2	1			650	= Grandtotal		

Spring.

In 14 samples, 193 finfish of 14 species were collected in the lower St. Jones River during the spring of 1995 (Table 9). Six finfish species comprised over 90% of the total. In order of decreasing abundance, these species are listed with their percent of total taken: white perch (36%), Atlantic silverside (17%), spotted hake (*Urophycis regia* 16%), mummichog (10%), Atlantic herring (*Clupea harengus* 6%), and hogchoker (*Trinectes maculatus* 6%). The majority of finfish collected were taken in samples from the secondary tributaries and guts.

Reserve overview

The finfish community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 88 separate samples collected over three seasons, contained 9599 specimens of 34 species (Table 10). The lower St. Jones River had more finfish species collected (25) than did upper Blackbird Creek (21). About equal numbers of finfish were collected in samples taken from each portion of the reserve.

Six species constituted over 92% of the total catch. In order of decreasing abundance, these species are listed with their percent of total taken: spot (33%), mummichog (17%), Atlantic menhaden (13%), Atlantic silverside (13%), white perch (10%), and sheepshead minnow (7%). These six species include two that are estuarine dependant (spot and Atlantic menhaden), and four that are estuarine resident (mummichog, Atlantic silverside, white perch and sheepshead minnow). The majority of spot, white perch, and all of the Atlantic menhaden were collected from upper Blackbird Creek, and the majority of mummichog, Atlantic silverside and all of the sheepshead minnow, were

Table 9

Summary of fish collected from the lower St. Jones River portion of the DNERR area, during the spring of 1995.

Species	Upper Study Area Sub divisions						Lower Study Area Sub divisions						Bay Study Area				Subtotals	Percent of total	Cumulative Percent of total
	Main	2.		3.		Pools	Main	2.		3.		Inshore		Shorezone					
		2.	gut	2.	3.			2.	3.	Rep 1	Rep 2	Rep 1	Rep 2						
White perch	4	41					2	23									70	36.27%	36.27%
Atlantic silverside						2		25					3	3			33	17.10%	53.37%
Spotted hake							6	2			22						30	15.54%	68.91%
Mummichog			6			7			3	3							19	9.84%	78.76%
Atlantic herring									2				8	2			12	6.22%	84.97%
Hogchoker	2	2					5	1			1						11	5.70%	90.67%
Striped mullet									3								4	2.07%	92.75%
Bay anchovy											1	2					3	1.55%	94.30%
Sheepshead minnow									1	1							3	1.55%	95.85%
Black sea bass						1											2	1.04%	96.89%
American eel							2										2	1.04%	97.93%
Northern searobin												2					2	1.04%	98.96%
Striped bass													1				1	0.52%	99.48%
Oyster toadfish																	1	0.52%	100.00%
Subtotals	6	43	7	0	10	15	26	34	4	0	30	2	11	5		193		= Grandtotal	

Table 10

Total numbers of fish collected from the upper Blackbird Creek and lower St. Jones River portions of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Species	Sample location		Subtotal	Percent of total	Cumulative Percent of total
	Blackbird creek	St. Jones river			
Spot	2319	829	3148	32.80%	32.80%
Mummichog	523	1143	1666	17.36%	50.15%
Atlantic menhaden	1241		1241	12.93%	63.08%
Atlantic silverside	18	1198	1216	12.67%	75.75%
White perch	585	342	927	9.66%	85.40%
Sheepshead minnow		634	634	6.60%	92.01%
Bay anchovy	3	281	284	2.96%	94.97%
Hogchoker	78	65	143	1.49%	96.46%
Weakfish	19	51	70	0.73%	97.19%
Striped bass	36	29	65	0.68%	97.86%
American eel	20	32	52	0.54%	98.41%
Spotted hake		31	31	0.32%	98.73%
Black drum	5	21	26	0.27%	99.00%
Brown bullhead	16		16	0.17%	99.17%
Silvery minnow	15		15	0.16%	99.32%
Atlantic herring		12	12	0.13%	99.45%
Atlantic croaker		10	10	0.10%	99.55%
Channel catfish	4	4	8	0.08%	99.64%
Silver perch		5	5	0.05%	99.69%
Striped killifish		4	4	0.04%	99.73%
Striped mullet		4	4	0.04%	99.77%
Gizzard shad	3		3	0.03%	99.80%
Inland silverside	1	2	3	0.03%	99.83%
Black sea bass		2	2	0.02%	99.85%
Bluefish		2	2	0.02%	99.87%
Northern searobin		2	2	0.02%	99.90%
Oyster toadfish		2	2	0.02%	99.92%
Yellow perch	2		2	0.02%	99.94%
Banded killifish		1	1	0.01%	99.95%
Black crappie	1		1	0.01%	99.96%
Blueback herring	1		1	0.01%	99.97%
Bluegill	1		1	0.01%	99.98%
Pumpkinseed	1		1	0.01%	99.99%
Summer flounder		1	1	0.01%	100.00%
Subtotals =	4892	4707	9599	= Grandtotal	

collected in the lower St. Jones River. For both areas of the reserve, the maximum numbers of finfish were collected in the summer, and the minimum numbers in the spring.

Aquatic Macroinvertebrates

Upper Blackbird Creek represents the oligohaline portion of the reserve, where salinities generally range between 0.5 and 5 ppt. Yearly ranges for selected physicochemical parameters were: temperature, 12 - 30 °C; salinity, 2.5 - 7.0 ppt; and dissolved oxygen, 3.0 - 12.0 ppm.

The St. Jones River is the mesohaline portion of the reserve, where salinities generally range between mesohaline definition range of 3.0 to 16.5 ppt. Yearly physicochemical ranges were: temperature, 12.0 - 22.2 °C; salinity, 5.0 - 24.0 ppt; and dissolved oxygen 2.3 - 10.0 ppt.

The taxa representing at least 90 percent of the total mean densities sampled will be discussed in detail.

Upper Blackbird Creek

Benthic macroinvertebrates

General species composition and abundance

The upper Blackbird Creek benthic macroinvertebrate community was represented by 21 taxa of three phyla (Table 11). The phyla were: annelida (segmented worms, such as aquatic earthworms, clamworms and leeches), arthropoda (insects and crustaceans), and nemertea (ribbon worms). The total mean density (n/m^2 , where n =numbers of individuals) for all sampling stations in all seasons was 2944. Five taxa comprised over 92 percent of the total. In order of decreasing abundance, these were: oligochaeta, chironomidae, *Corophium* sp., *Gammarus* sp., and *Cyathura polita*.

The oligochaetes (aquatic earthworms) with mean density of 1601 represented 54% of the total catch. This was over 2.6 times greater than the next most abundant taxon, the chironomids (midges, a fly with aquatic young life stages), whose density was 601, or 20% of the total. Both larval and pupal chironomids were taken, but the larval lifestage was vastly predominant.

The amphipods (scuds or sideswimmers) *Corophium* sp. and *Gammarus* sp., with mean densities of 320 and 114, respectively, represented nearly 11 and 4% of the total catch. The isopod (aquatic pillbug) *Cyathura polita*, was found at mean densities of 89, which comprised 3% of the total. Of the 16 remaining taxa, representing less than 6% of the total mean densities, five were clamworms, eight were crustaceans, two were insect larvae, and one was a ribbonworm.

The blue crab, *Callinectes sapidus*, and mud crabs of the family Xanthidae were collected in the gear deployed for the finfish monitoring portion of this study. Both crab taxa were present during every season, but most were captured in the summer samples. They were collected in every habitat except for the permanent pool areas.

Table 11

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the upper Blackbird Creek portion of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	1601	54.4%	54.4%
Chironomidae	601	20.4%	74.8%
Corophium sp.	320	10.9%	85.7%
Gammarus sp.	114	3.9%	89.6%
Cyathura polita	89	3.0%	92.6%
Nereis succinea	52	1.8%	94.4%
Polydora ligni	32	1.1%	95.5%
Edotea triloba	30	1.0%	96.5%
Scolecopides viridis	27	0.9%	97.4%
Xanthidae	22	0.7%	98.1%
Gammaridae	16	0.5%	98.7%
Parapluestes aestuarius	12	0.4%	99.1%
Hypaniola florida	8	0.3%	99.4%
Neomysis americana	5	0.2%	99.5%
Nemertea	4	0.1%	99.7%
Streblospio benedicti	3	0.1%	99.8%
Chiridotea almyra	1	0.0%	99.8%
Diptera	1	0.0%	99.9%
Ceratopogonidae	1	0.0%	99.9%
Rhithropanopeus harrisi	1	0.0%	100.0%
Melita nitida	1	0.0%	100.0%
Total mean density	2944		

Table 12

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the upper Blackbird Creek portion of the DNERR area, for the summer of 1994.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	826	40.5%	40.5%
Chironomidae	589	28.9%	69.4%
Cyathura polita	137	6.7%	76.1%
Gammarus sp.	132	6.5%	82.6%
Corophium sp.	86	4.2%	86.8%
Nereis succinea	78	3.8%	90.6%
Xanthidae	43	2.1%	92.7%
Polydora ligni	43	2.1%	94.9%
Edotea triloba	35	1.7%	96.6%
Parapluestes aestuarius	24	1.2%	97.8%
Scolecopides viridis	24	1.2%	98.9%
Hypaniola florida	8	0.4%	99.3%
Nemertea	3	0.1%	99.5%
Melita nitida	3	0.1%	99.6%
Chiridotea almyra	3	0.1%	99.7%
Diptera	3	0.1%	99.9%
Ceratopogonidae	3	0.1%	100.0%
Total mean density	2040		

Table 13

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the upper Blackbird Creek portion of the DNERR area, for the fall of 1994.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2115	62.1%	62.1%
Chironomidae	818	24.0%	86.1%
Corophium sp.	248	7.3%	93.4%
Gammarus sp.	65	1.9%	95.3%
Scolecopides viridis	59	1.7%	97.0%
Edotea triloba	38	1.1%	98.1%
Cyathura polita	27	0.8%	98.9%
Nemertea	11	0.3%	99.2%
Nereis succinea	11	0.3%	99.5%
Polydora ligni	5	0.2%	99.7%
Neomysis americana	5	0.2%	99.8%
Hypaniola florida	5	0.2%	100.0%
Total mean density	3407		

Table 14

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the upper Blackbird Creek portion of the DNERR area, for the spring of 1995.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2637	61.5%	61.5%
Corophium sp.	861	20.1%	81.6%
Chironomidae	409	9.5%	91.1%
Gammarus sp.	129	3.0%	94.1%
Gammaridae	65	1.5%	95.6%
Cyathura polita	54	1.3%	96.9%
Nereis succinea	43	1.0%	97.9%
Polydora ligni	38	0.9%	98.7%
Neomysis americana	16	0.4%	99.1%
Streblospio benedicti	11	0.3%	99.4%
Edotea triloba	11	0.3%	99.6%
Hypaniola florida	11	0.3%	99.9%
Rhithropanopeus harrisi	5	0.1%	100.0%
Total mean density	4289		

Seasonal characterizations

The total densities (n/m^2) of benthic macroinvertebrate taxa present in upper Blackbird Creek ranged from a minimum of 2040 during the summer, to the seasonal maximum of 4289 in the spring. During all three seasons oligochaetes were always the most abundant taxon sampled, with mean densities ranging from 826 to 2637 in the summer and spring, respectively (Tables 12 through 14). They composed from 41 to over 62% of the total density sampled.

Summer

In 16 benthic grabs taken from upper Blackbird Creek during the summer, 17 taxa were identified (Table 12). The total mean density (n/m^2) was 2040. Six taxa comprised over 90% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (826, 41%), chironomidae (589, 29%), *Cyathura polita* (137, 7%), *Gammarus* sp. (132, 7%), *Corophium* sp. (86, 4%), and *Nereis succinea* (78, 4%). Of the 11 remaining taxa, representing 7% of the total, five were crustaceans, three were clamworms, two were insect larvae, and one was a flatworm.

Fall

In 8 benthic grabs taken from upper Blackbird Creek during the fall, 12 taxa were identified (Table 13). The total mean density (n/m^2) was 3407 and three taxa comprised over 93% percent of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (2115, 62%), chironomidae (818, 24%) and *Corophium* sp. (248, 7%). The remaining 9 taxa comprised less than six percent of the total, and were split between crustaceans and

clamworms (four each), and one ribbonworm.

Spring

In 8 benthic grabs taken from the upper Blackbird Creek during the spring, 13 taxa were collected (Table 14). The total mean density (n/m^2) was 4289. Three taxa made up over 91% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (2637, 62%), *Corophium* sp. (861, 20%), and chironomidae (409, 10%). The remaining 10 taxa comprised less than six percent of the total, and included six crustaceans and four clamworms.

Parabenthic macroinvertebrates

General species composition and abundance

The upper Blackbird Creek parabenthic macroinvertebrate community was represented by 11 taxa of four phyla (Table 15). The phyla represented were: arthropoda, annelida, cnidaria (jellyfish) and ctenophora (comb jellies). The total mean density ($n/100m^3$) for all sampling stations in all seasons was 487. Four taxa, all crustaceans, comprised almost 95% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: the grass shrimp *Palaemonetes* sp. (303, 62%), the amphipod *Gammarus* sp. (77, 16%), the opossum shrimp *Neomysis americana* (54, 11%), and the scud *Corophium* sp. (26, 5%). The remaining seven taxa represented less than 3% of the total mean density and included four crustaceans, one clamworm, one aquatic earthworm, and one midge larvae.

Table 15

Total mean densities of parabenitic macroinvertebrates collected by 0.5 m 500 micron plankton net from the upper Blackbird Creek portion of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
<i>Palaemonetes</i> sp.	303	62.3%	62.3%
<i>Gammarus</i> sp.	77	15.8%	78.1%
<i>Neomysis americana</i>	54	11.1%	89.2%
<i>Corophium</i> sp.	26	5.4%	94.6%
<i>Nereis succinea</i>	14	2.9%	97.4%
Gammaridae	4	0.7%	98.1%
<i>Argulus</i> sp.	3	0.7%	98.8%
<i>Edotea triloba</i>	3	0.5%	99.3%
<i>Lironeca ovalis</i>	1	0.3%	99.6%
Oligochaeta	1	0.2%	99.8%
Chironomidae	1	0.2%	100.0%
Total mean density	487		

Table 16

Total mean densities of parabenitic macroinvertebrates collected by 0.5 m 500 micron plankton net from the upper Blackbird Creek portion of the DNERR area, for the summer of 1994.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
<i>Palaemonetes</i> sp.	607	84.5%	84.5%
<i>Gammarus</i> sp.	61	8.5%	93.0%
<i>Nereis succinea</i>	28	3.9%	96.8%
Gammaridae	7	1.0%	97.8%
<i>Argulus</i> sp.	6	0.9%	98.7%
<i>Edotea triloba</i>	5	0.6%	99.3%
<i>Corophium</i> sp.	2	0.3%	99.7%
<i>Lironeca ovalis</i>	2	0.3%	100.0%
Total mean density	719		

Table 17

Total mean densities of parabenitic macroinvertebrates collected by 0.5 m 500 micron plankton net from the upper Blackbird Creek portion of the DNERR area, for the fall of 1994.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
<i>Neomysis americana</i>	202	63.6%	63.6%
<i>Corophium</i> sp.	76	23.9%	87.5%
<i>Gammarus</i> sp.	34	10.8%	98.3%
Oligochaeta	4	1.4%	99.6%
<i>Edotea triloba</i>	1	0.4%	100.0%
Total mean density	317		

Table 18

Total mean densities of parabenitic macroinvertebrates collected by 0.5 m 500 micron plankton net from the upper Blackbird Creek portion of the DNERR area, for the spring of 1995.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
<i>Gammarus</i> sp.	152	77.8%	77.8%
<i>Corophium</i> sp.	24	12.5%	90.3%
<i>Neomysis americana</i>	15	7.7%	98.0%
Chironomidae	4	2.0%	100.0%
Total mean density	195		

In addition, the presence of the zoea and megalopa lifestages of brachyuran crabs, and jellyfish (cnidarian medusa) were noted, but not counted, during the summer.

Seasonal characteristics

Within the upper Blackbird Creek, the total density (n/100m³) of parabenthic macroinvertebrate taxa identified ranged from a minimum of 195 during the spring, to the seasonal maximum of 719 in the summer (Tables 16 through 18).

For all three seasons, crustaceans were the most abundant parabenthic taxa sampled, although no one taxon was predominant for more than one season. These taxa included *Palaemonetes* sp., *Neomysis americana*, *Gammarus* sp., and *Corophium* sp.

Summer

In four parabenthic macroinvertebrate samples collected from the upper Blackbird Creek during the summer, eight taxa were identified (Table 16), with a total mean density (n/100m³) of 719. Two taxa, *Palaemonetes* sp. and *Gammarus* sp., comprised nearly 93% of the total. Mean densities were 607 and 61, respectively. The six remaining taxa included five crustaceans, and one clamworm.

Observed, but not quantified were the zoea and megalopa larvae of brachyuran crabs, jellyfish (cnidarian medusa), and comb jellies (ctenophora).

Fall

In two parabenthic macroinvertebrate samples collected from the upper Blackbird Creek

during the fall, five taxa were identified (Table 17). The total mean density ($n/100m^3$) was 317. Three of these taxa comprised over 98% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: *Neomysis americana* (202, 64%), *Corophium* sp. (76, 24%), and *Gammarus* sp. (34, 11%). The remaining taxa represented less than one percent of the total catch, and included an annelid and a crustacean.

Spring

In two parabenthic macroinvertebrate samples collected from the upper Blackbird Creek during the spring, four taxa were taken (Table 18). The total mean density ($n/100m^3$) was 195. Two taxa, *Gammarus* sp., and *Corophium* sp., accounted for over 90% of the total parabenthic macroinvertebrates captured, and their densities and percent of the total catch were, respectively, 152 (78%), and 24 (13%). The remaining taxa comprising less than 2% of the catch were a midge larvae and a crustacean.

Jellyfish were observed as a component of the parabenthic macroinvertebrate collection, but were not quantified.

Lower St. Jones River

Benthic macroinvertebrates

General species composition and abundance

The lower St. Jones River benthic macroinvertebrate community was represented by 33 taxa of five phyla (Table 19). The five phyla represented were: annelida (segmented

worms), arthropoda (insects, crustaceans, and horseshoe crabs), platyhelminthes (flatworms), mollusca (snails and clams), and nemertea (ribbonworms). The total mean density (n/m^2) for all stations and seasons was 4156. Ten taxa represented 92% of the total catch. In order of decreasing abundance, these taxa were: oligochaeta, chironomidae, *Corophium* sp., polychaeta, *Neomysis americana*, *Edotea triloba*, *Streblospio benedicti*, *Gammarus* sp., *Ilyanassa* sp., and turbellaria.

The oligochaetes or aquatic earthworms, a type of annelid were the most abundant taxa sampled. With a mean density (n/m^2) of 2425, they comprised over 58% of the total catch. They were more than six times as numerous as the next most abundant taxon, the chironomids, or midge larvae. The mean density of the chironomids was 389, and represented over 9% of the total.

The remaining dominant taxa, in order of decreasing abundance, are listed with their mean densities and percent of total taken: the scud, *Corophium* sp. (221, 5%), unidentified clamworms of the class polychaeta (134, 3%), the opossum shrimp, *Neomysis americana* (131, 3%), the aquatic pillbug, *Edotea triloba* (120, 3%), the clamworm, *Streblospio benedicti* (111, 3%), the scud, *Gammarus* sp. (101, 2%), the mud snail, *Ilyanassa* sp. (98, 2%), and free-living flatworms or turbellarians (92, 2%).

Of the 23 taxa remaining comprising 6% of the total mean densities observed, ten were crustaceans, six were sandworms (polychaetes), four were molluscs, one was a horseshoe crab (a relative of the spider), one was a leach, and one was a nemertean ribbonworm.

Qualitative observations of benthic macroinvertebrates were also recorded. Just inside the mouth of the St. Jones River is an oyster bar that could not be sampled with the

ponar grab due to its jamming with oyster shells. Live American oysters, *Crassostrea virginica*, were noted during every season sampled. Adult horseshoe crabs (*Limulus polyphemus*) were seen on the beach at the River's mouth in the summer, and were captured in the channel nets used to sample the finfish population in the secondary tributary near the mouth of the River. The ribbed mussel *Geukensia demissa* and fiddler crabs (*Uca* spp.) were distributed throughout the marsh, from the waters edge of channels and tributaries, through the high marsh on up to the treeline, during all seasons. Mud snails of the genus *Ilyanassa* spp. were seen covering exposed mudflats and creek bottoms at or near low tide. The blue crab, *Callinectes sapidus*, and mud crabs of the family Xanthidae were collected in the trap nets, seines, and trawl gear deployed for finfish collection, during all seasons.

Seasonal characterizations

The total densities (n/m^2) of benthic macroinvertebrate taxa collected in the lower St. Jones River ranged from 3850 during the summer, to the seasonal maximum of 4573 in the spring (Tables 20 through 22).

Oligochaeta were the most dominant taxon sampled during all three seasons, ranging from 2191 to 2756. This represented from 56 (summer and spring) to over 63% (fall) of the total mean density of benthic macroinvertebrates. The oligochaetes were from 3.7 to 6.9 times more abundant than the next highest density taxon.

The other dominant taxa contributing to more than 90% of the total mean densities usually included amphipods, isopods, gastropods, polychaetes, and chironomids, any of

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2425	58.3%	58.3%
Chironomidae	389	9.4%	67.7%
Corophium sp.	221	5.3%	73.0%
Polychaeta	134	3.2%	76.2%
Neomysis americana	131	3.2%	79.4%
Edotea triloba	120	2.9%	82.3%
Streblospio benedicti	111	2.7%	85.0%
Gammarus sp.	101	2.4%	87.4%
Ilyanassa sp.	98	2.4%	89.8%
Turbellaria	92	2.2%	92.0%
Polydora ligni	85	2.0%	94.0%
Gammaridae	53	1.3%	95.3%
Nereis succinea	52	1.2%	96.5%
Scolecoplepides viridis	39	0.9%	97.5%
Bivalvia	32	0.8%	98.2%
Hypaniola florida	19	0.5%	98.7%
Cyathura polita	18	0.4%	99.1%
Nemertea	10	0.2%	99.4%
Sphaeriidae	5	0.1%	99.5%
Eurypanopeus depressus	4	0.1%	99.6%
Xanthidae	3	0.1%	99.7%
Glycera sp.	2	0.1%	99.7%
Isopoda	2	0.1%	99.8%
Palaemonetes sp.	2	0.0%	99.8%
Caecidotea spp.	2	0.0%	99.9%
Gastropoda	1	0.0%	99.9%
Urosalpinx cinera	1	0.0%	99.9%
Chiridotea almyra	1	0.0%	99.9%
Spionidae	1	0.0%	99.9%
Melita nitida	1	0.0%	99.9%
Hirudinea	1	0.0%	100.0%
Idotea sp.	1	0.0%	100.0%
Limulus polyphemus	1	0.0%	100.0%
Total mean density	4156		

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2191	56.9%	56.9%
Chironomidae	581	15.1%	72.0%
Polychaeta	243	6.3%	78.3%
Edotea triloba	157	4.1%	82.4%
Gammarus sp.	108	2.8%	85.2%
Nereis succinea	92	2.4%	87.6%
Corophium sp.	85	2.2%	89.8%
Ilyanassa sp.	85	2.2%	92.0%
Scolecoplepides viridis	66	1.7%	93.7%
Polydora ligni	62	1.6%	95.3%
Gammaridae	54	1.4%	96.7%
Bivalvia	28	0.7%	97.4%
Cyathura polita	26	0.7%	98.1%
Streblospio benedicti	22	0.6%	98.6%
Hypaniola florida	11	0.3%	98.9%
Sphaeriidae	9	0.2%	99.2%
Xanthidae	6	0.2%	99.3%
Eurypanopeus depressus	5	0.1%	99.4%
Neomysis americana	5	0.1%	99.6%
Palaemonetes sp.	3	0.1%	99.6%
Limulus polyphemus	2	0.0%	99.7%
Glycera sp.	2	0.0%	99.7%
Gastropoda	2	0.0%	99.8%
Urosalpinx cinera	2	0.0%	99.8%
Chiridotea almyra	2	0.0%	99.8%
Nemertea	2	0.0%	99.9%
Idotea sp.	2	0.0%	99.9%
Melita nitida	2	0.0%	100.0%
Spionidae	2	0.0%	100.0%
Total mean density	3850		

worms), arthropoda (insects, crustaceans, and horseshoe crabs), platyhelminthes (flatworms), mollusca (snails and clams), and nemertea (ribbonworms). The total mean density (n/m^2) for all stations and seasons was 4156. Ten taxa represented 92% of the total catch. In order of decreasing abundance, these taxa were: oligochaeta, chironomidae, *Corophium* sp., polychaeta, *Neomysis americana*, *Edotea triloba*, *Streblospio benedicti*, *Gammarus* sp., *Ilyanassa* sp., and turbellaria.

The oligochaetes or aquatic earthworms, a type of annelid were the most abundant taxa sampled. With a mean density (n/m^2) of 2425, they comprised over 58% of the total catch. They were more than six times as numerous as the next most abundant taxon, the chironomids, or midge larvae. The mean density of the chironomids was 389, and represented over 9% of the total.

The remaining dominant taxa, in order of decreasing abundance, are listed with their mean densities and percent of total taken: the scud, *Corophium* sp. (221, 5%), unidentified clamworms of the class polychaeta (134, 3%), the opossum shrimp, *Neomysis americana* (131, 3%), the aquatic pillbug, *Edotea triloba* (120, 3%), the clamworm, *Streblospio benedicti* (111, 3%), the scud, *Gammarus* sp. (101, 2%), the mud snail, *Ilyanassa* sp. (98, 2%), and free-living flatworms or turbellarians (92, 2%).

Of the 23 taxa remaining comprising 6% of the total mean densities observed, ten were crustaceans, six were sandworms (polychaetes), four were molluscs, one was a horseshoe crab (a relative of the spider), one was a leach, and one was a nemertean ribbonworm.

Qualitative observations of benthic macroinvertebrates were also recorded. Just inside the mouth of the St. Jones River is an oyster bar that could not be sampled with the

ponar grab due to its jamming with oyster shells. Live American oysters, *Crassostrea virginica*, were noted during every season sampled. Adult horseshoe crabs (*Limulus polyphemus*) were seen on the beach at the River's mouth in the summer, and were captured in the channel nets used to sample the finfish population in the secondary tributary near the mouth of the River. The ribbed mussel *Geukensia demissa* and fiddler crabs (*Uca* spp.) were distributed throughout the marsh, from the waters edge of channels and tributaries, through the high marsh on up to the treeline, during all seasons. Mud snails of the genus *Ilyanassa* spp. were seen covering exposed mudflats and creek bottoms at or near low tide. The blue crab, *Callinectes sapidus*, and mud crabs of the family Xanthidae were collected in the trap nets, seines, and trawl gear deployed for finfish collection, during all seasons.

Seasonal characterizations

The total densities (n/m^2) of benthic macroinvertebrate taxa collected in the lower St. Jones River ranged from 3850 during the summer, to the seasonal maximum of 4573 in the spring (Tables 20 through 22).

Oligochaeta were the most dominant taxon sampled during all three seasons, ranging from 2191 to 2756. This represented from 56 (summer and spring) to over 63% (fall) of the total mean density of benthic macroinvertebrates. The oligochaetes were from 3.7 to 6.9 times more abundant than the next highest density taxon.

The other dominant taxa contributing to more than 90% of the total mean densities usually included amphipods, isopods, gastropods, polychaetes, and chironomids, any of

Table 21

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the lower St. Jones River portion of the DNERR area, for the fall of 1994.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2756	63.3%	63.3%
Corophium sp.	504	11.6%	74.9%
Streblospio benedicti	277	6.4%	81.3%
Chironomidae	215	4.9%	86.2%
Neomysis americana	197	4.5%	90.7%
Edotea triloba	135	3.1%	93.9%
Gammarus sp.	86	2.0%	95.8%
Hypania florida	65	1.3%	97.1%
Hyanessa sp.	31	0.7%	97.8%
Polydora ligni	28	0.6%	98.4%
Scolecopides viridis	22	0.5%	98.9%
Cyathura polita	15	0.4%	99.3%
Polychaeta	9	0.2%	99.5%
Nemertea	6	0.1%	99.6%
Nereis succinea	6	0.1%	99.8%
Glycera sp.	6	0.1%	99.9%
Bivalvia	3	0.1%	100.0%
Total mean density	4352		

Table 22

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the lower St. Jones River portion of the DNERR area, for the spring of 1995.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2562	56.0%	56.0%
Turbellaria	369	8.1%	64.1%
Neomysis americana	320	7.0%	71.1%
Corophium sp.	209	4.6%	75.7%
Hyanessa sp.	194	4.2%	79.9%
Polydora ligni	188	4.1%	84.0%
Chironomidae	178	3.9%	87.9%
Streblospio benedicti	126	2.8%	90.7%
Gammaridae	105	2.3%	92.9%
Gammarus sp.	105	2.3%	95.2%
Bivalvia	68	1.5%	96.7%
Polychaeta	40	0.9%	97.6%
Nemertea	31	0.7%	98.3%
Edotea triloba	31	0.7%	98.9%
Nereis succinea	15	0.3%	99.3%
Isopoda	9	0.2%	99.5%
Cyathura polita	6	0.1%	99.6%
Eurypanopeus depressus	6	0.1%	99.7%
Caecidotea sp.	6	0.1%	99.9%
Scolecopides viridis	3	0.1%	99.9%
Hirudinea	3	0.1%	100.0%
Total mean density	4573		

Table 23

Total mean densities of parabenthic macroinvertebrates collected by 0.5 m 500 micron plankton net from the lower St. Jones River portion of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
Neomysis americana	5308	92.3%	92.3%
Edotea triloba	244	4.2%	96.5%
Corophium sp.	100	1.7%	98.3%
Chironomidae	53	0.9%	99.2%
Palaemonetes sp.	32	0.6%	99.7%
Gammarus sp.	9	0.2%	99.9%
Gammaridae	4	0.1%	100.0%
Limulus polyphemus	1	0.0%	100.0%
Lironca ovalis	1	0.0%	100.0%
Total mean density	5752		

Table 24

Total mean densities of parabenthic macroinvertebrates collected by 0.5 m 500 micron plankton net from the lower St. Jones River portion of the DNERR area, for the summer of 1994.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
Edotea triloba	160	27.7%	27.7%
Corophium sp.	159	27.5%	55.2%
Chironomidae	106	18.3%	73.5%
Neomysis americana	78	13.6%	87.1%
Palaemonetes sp.	64	11.1%	98.2%
Gammarus sp.	5	0.9%	99.1%
Limulus polyphemus	2	0.3%	99.5%
Gammaridae	2	0.3%	99.8%
Lironca ovalis	1	0.2%	100.0%
Total mean density	578		

Table 25

Total mean densities of parabenthic macroinvertebrates collected by 0.5 m 500 micron plankton net from the lower St. Jones River portion of the DNERR area, for the fall of 1994.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
Neomysis americana	20460	95.5%	95.5%
Edotea triloba	657	3.1%	99.6%
Corophium sp.	75	0.4%	99.9%
Gammarus sp.	18	0.1%	100.0%
Total mean density	21210		

Table 26

Total mean densities of parabenthic macroinvertebrates collected by 0.5 m 500 micron plankton net from the lower St. Jones River portion of the DNERR area, for the spring of 1995.

Taxon	Density per 100 m ²	Percent of Total	Cumulative Percent of Total
Neomysis americana	614	95.5%	95.5%
Gammaridae	11	1.7%	97.2%
Corophium sp.	9	1.3%	98.5%
Gammarus sp.	8	1.2%	99.8%
Hirudinea	0	0.1%	99.9%
Chironomidae	0	0.1%	99.9%
Nereidae	0	0.1%	100.0%
Total mean density	643		

which constituted no more than 3% of the total. After the oligochaetes, the ranking of dominant taxa varied with the season.

Summer

In 28 benthic grabs collected from the lower St. Jones River during the summer, a seasonal maximum of 29 taxa were identified (Table 20). The total mean density (n/m^2) was 3850, and eight taxa constituted 92% of the total density. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (2191, 57%), chironomidae (581, 15%), polychaeta (243, 6%), *Edotea triloba*, (157, 4%), *Gammarus* sp. (108, 3%), a polychaete, *Nereis succinea* (92, 2%), *Corophium* sp. (85, 2%), and *Ilyanassa* sp. (85, 2%). The 21 remaining taxa included nine crustaceans, six clamworms (polychaetes), four molluscs, one ribbonworm, and one horseshoe crab.

Fall

In 14 benthic grabs collected from the lower St. Jones River during the fall, 17 taxa were identified (Table 21). The total mean density (n/m^2) was 4352, and five taxa comprised over 90% of the total organisms sampled. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (2756, 63%), *Corophium* sp. (504, 12%), a polychaete, *Streblospio benedicti* (277, 6%), chironomidae (215, 5%), and *Neomysis americana* (197, 5%). The other taxa contributed less than 7% of the total mean density, and included six clamworms, three crustaceans, two molluscs and one ribbonworm.

Spring

In 14 benthic grabs collected from the lower St. Jones River during the spring, 21 taxa

were identified (Table 22). The total mean density (n/m^2) was 4573. Eight taxa comprised over 90% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: oligochaeta (2562, 56%), turbellaria (369, 8%), *Neomysis americana* (320, 7%), *Corophium* sp. (209, 5%), *Ilyanassa* sp. (194, 4%), a polychaete, *Polydora ligni* (188, 4%), chironomidae (178, 4%), and *Streblospio benedicti* (126, 3%). The remaining 13 taxa included seven crustaceans, three clamworms, one clam, one ribbonworm and one leech.

Parabenthic macroinvertebrates

General species composition and abundance

The lower St. Jones River parabenthic macroinvertebrate community was represented by nine taxa (Table 23). For all stations in all seasons, total mean density ($n/100m^3$) was 5752. Four phyla were represented, the arthropoda, annelida, cnidaria, and ctenophora. However, only the arthropods, and more specifically one species of crustacean, the opossum shrimp *Neomysis americana*, predominated. This single species, with a density of 5308, made up over 92% of the total specimens collected. Of the remaining eight taxa, only two contributed more than 1% of the total density. These taxa included six crustaceans, one midge larvae, and one horseshoe crab.

Seasonal characteristics

The total densities ($n/100m^3$) of the parabenthic macroinvertebrate taxa present collected in the lower St. Jones River ranged from a minimum of 578 during the summer, to the maximum of 21,210 in the fall (Tables 24 through 26). For all seasons, the dominant

group of taxa were the crustaceans, except for 18% of the summer sample, which were midge larvae. For the fall and spring seasons, *Neomysis americana* was the predominant taxon. Its density of 20,460 in the fall was orders of magnitude above that of any other taxa in any season. During the summer, the isopod *Edotea triloba* had the highest densities at 160.

Summer

In ten parabenthic macroinvertebrate samples collected from the lower St. Jones River during the summer, nine taxa were identified (Table 24). The total mean density ($n/100m^3$) was 578. Five taxa comprised over 98% of the total. In order of decreasing abundance, these taxa are listed with their mean densities and percent of total taken: *Edotea triloba* (160, 28%), *Corophium* sp. (159, 28%), chironomidae (106, 18%), *Neomysis americana* (78, 14%), and *Palaemonetes* sp. (64, 11%). The remaining four taxa included three crustaceans and one horseshoe crab.

In addition, the presence of other taxa were noted but not quantified. These included the zoea and megalopa lifestages of brachyuran crabs, jellyfish such as the sea nettle (*Chrysaora quinquecirrha*) and the moon jellyfish (*Aurelia aurita*), and comb jellies (the sea walnut *Mnemiopsis leidyi*).

Fall

In five parabenthic macroinvertebrate samples collected from the lower St. Jones River during the fall, four taxa were identified (Table 25). Total mean density ($n/100m^3$) was 21,210. Only one taxon predominated, *Neomysis americana*, with a total mean density of 20,460, which comprised over 96% of the total density. The remaining three taxa were all crustaceans.

Spring

In five parabenithic macroinvertebrate samples collected from the lower St. Jones River during the spring, seven taxa were identified (Table 26), with a total mean density ($n/100m^3$) of 643. As in the fall, *Neomysis americana* predominated, with a density of 614, which was 96% of the total density. The remainder of the taxa collected consisted of three crustaceans, one leech, one midge larvae, and one clamworm. During the spring jellyfish and ctenophora (the sea walnut *Mnemiopsis leidyi*) were observed but not quantified.

Reserve overview

Benthic macroinvertebrates

The benthic macroinvertebrate community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 88 petite ponar grab samples collected over three seasons, contained 37 taxa of 5 phyla: annelida, arthropoda, mollusca, platyhelminthes, and nemertea. More benthic macroinvertebrate taxa were collected in the lower St. Jones River (33) portion than in the upper Blackbird Creek (21).

Total mean density (n/m^2) of all taxa for both areas and all seasons was 3715 (Table 27). Nine taxa constituted over 90% of the total. In order of decreasing abundance, these taxa are listed with their mean densities (n/m^2) and percent of total taken: oligochaeta (2125, 57%), chironomidae (466, 13%), *Corophium* sp. (257, 7%), *Gammarus* sp. (106, 3%), *Edotea triloba* (87, 2%), *Neomysis americana* (86, 2%), unidentified polychaeta (85,

Table 27

Total mean densities of benthic macroinvertebrates collected by petite ponar grab from the upper Blackbird Creek, and lower St. Jones River portions of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Taxon	Density per m ²	Percent of Total	Cumulative Percent of Total
Oligochaeta	2125	57.2%	57.2%
Chironomidae	466	12.5%	69.8%
Corophium sp.	257	6.9%	76.7%
Gammarus sp.	106	2.9%	79.5%
Edotea triloba	87	2.3%	81.9%
Neomysis americana	86	2.3%	84.2%
Polychaeta	85	2.3%	86.5%
Streblospio benedicti	72	1.9%	88.4%
Polydora ligni	66	1.8%	90.2%
Nassarius sp.	63	1.7%	91.8%
Turbellaria	59	1.6%	93.4%
Nereis succinea	52	1.4%	94.8%
Cyathura polita	44	1.2%	96.0%
Gammaridae	40	1.1%	97.1%
Scolecopelides viridis	35	0.9%	98.0%
Bivalvia	20	0.5%	98.6%
Hypaniola florida	15	0.4%	99.0%
Xanthidae	10	0.3%	99.2%
Nemertea	8	0.2%	99.4%
Parapluteus aestuarius	4	0.1%	99.6%
Sphaeriidae	3	0.1%	99.6%
Eurypanopeus depressus	2	0.1%	99.7%
Glycera sp.	1	0.0%	99.7%
Isopoda	1	0.0%	99.8%
Chiridotea almyra	1	0.0%	99.8%
Melita nitida	1	0.0%	99.8%
Caecidotea sp.	1	0.0%	99.9%
Palaemonetes sp.	1	0.0%	99.9%
Cerastopogonidae	0	0.0%	99.9%
Urosalpinx cinerea	0	0.0%	99.9%
Spionidae	0	0.0%	99.9%
Gastropoda	0	0.0%	99.9%
Diptera	0	0.0%	99.9%
Rhithropanopeus harrisi	0	0.0%	100.0%
Hirudinea	0	0.0%	100.0%
Idotea sp.	0	0.0%	100.0%
Limulus polyphemus	0	0.0%	100.0%
Total mean density	3715		

Table 30

Total mean densities of parabenthic macroinvertebrates collected by 0.5 m 500 micron plankton net from the Blackbird Creek, and lower St. Jones River portions of the DNERR area, for the summer and fall of 1994, and the spring of 1995.

Taxon	Density per 100 m ³	Percent of Total	Cumulative Percent of Total
Neomysis americana	3807	89.6%	89.6%
Edotea triloba	175	4.1%	93.8%
Palaemonetes sp.	110	2.6%	96.3%
Corophium sp.	79	1.9%	98.2%
Chironomidae	38	0.9%	99.1%
Gammarus sp.	29	0.7%	99.8%
Nereis succinea	4	0.1%	99.9%
Gammaridae	4	0.1%	100.0%
Lironca ovalis	1	0.0%	100.0%
Limulus polyphemus	1	0.0%	100.0%
Oligochaeta	0	0.0%	100.0%
Nereidae	0	0.0%	100.0%
Hirudinea	0	0.0%	100.0%
Total mean density	4247		

2%), *Streblospio benedicti* (72, 2%), and *Polydora ligni* (66, 2%). The remaining 28 taxa included 6 annelids (clamworms, aquatic earthworms, and leeches), 15 arthropods (crustaceans, insects, and horseshoe crabs), 5 molluscs (snails and clams), 1 nemertean (ribbonworm), and 1 turbellarian (flatworm).

The seasonal total mean densities of benthic macroinvertebrate taxa were always higher in the lower St. Jones River than in the upper Blackbird Creek. The total mean densities for all taxa within each season were, for the St. Jones and Blackbird areas respectively; summer 3850 and 2040, fall 4352 and 3407, and spring 4573 and 4289 (Tables 12 through 14, 19 through 22).

In both study areas, and during each season, the single most abundant benthic macroinvertebrate taxon was the oligochaeta (Tables 12 through 14, 19 through 22, and 27). With total mean densities (n/m^2) ranging from 826 to 2756, oligochaetes accounted for 41 to 63% of the total taxa collected. Oligochaete densities were higher in the St. Jones River than in the Blackbird Creek during the summer and fall. The total mean densities for oligochaetes for each season were, for the St. Jones and Blackbird areas respectively; summer 2191 and 826, fall 2756 and 2115, and spring 2562 and 2637.

The remainder of the taxa contributing to over 90% of the benthic macroinvertebrate densities collected from the Blackbird Creek during each season consistently included chironomidae, and the amphipod, *Corophium* sp. or the isopod, *Cyathura polita*. In contrast, the equivalent taxa of the St. Jones aquatic macroinvertebrate community varied greatly from season to season. The chironomidae were always represented, but other taxa included turbellaria, snails (*Ilyanassa* sp.), polychaetes such as *Nereis succinea*, *Streblospio benedicti*, or *Polydora ligni*, or crustaceans such as *Corophium* sp., *Neomysis*

americana, and *Gammarus* sp.

The distribution of benthic macroinvertebrates between habitats was examined for both portions of the DNERR area. The mean annual densities (n/m^2) for habitats in both systems are given in decreasing order: St. Jones 2° channel (4400), Blackbird Creek tidal river (3840), St. Jones tidal river (3781), St. Jones secondary gut (2298), and the Blackbird creek secondary channel (2048) (Tables 28 and 29). The benthic macroinvertebrate densities of the tidal rivers of both systems were near identical. The secondary channel of the St. Jones River had a density over twice that of the Blackbird creek.

In the St. Jones River secondary channel stations (ranked first in density), twenty-one taxa were identified, five of which comprised nearly 92% of the total catch (Table 29). Listed in order of decreasing abundance with their mean annual density in n/m^2 , these are: oligochaeta (3288), chironomidae (320), *Neomysis americana* (161), *Gammarus* sp. (129), and *Streblospio benedicti* (97).

In the Blackbird Creek tidal river channel stations (ranked second in density), thirteen taxa were identified, five of which comprised over 92% of the total catch (Table 28). Listed in order of decreasing abundance with their mean annual density in n/m^2 , these are: oligochaeta (1623), chironomidae (918), *Corophium* sp. (638), *Gammarus* sp. (199), and *Cyathura polita* (274).

In the St. Jones River tidal river stations (ranked third overall), twenty-two taxa were identified, seven of which comprised over 90% of the total catch (Table 29). Listed in order of decreasing abundance with their mean annual density in n/m^2 , these are:

Table 28

Benthic macroinvertebrate mean densities (number / m²) from the tidal river and 2_o channels of the Blackbird Creek portion of the DNERR area, all seasons combined (summer and fall 1994, and spring 1995).

Taxon	Tidal river stations				
	Upper	Lower	Mean	% total	Cum % total
Oligochaeta	646	2599	1623	42.3%	42.3%
Chironomidae	167	1668	918	23.9%	66.2%
Corophium sp.	22	1254	638	16.6%	82.8%
Gammarus sp.	129	269	199	5.2%	87.9%
Cyathura polita	81	274	178	4.6%	92.6%
Polydora ligni	75	54	65	1.7%	94.3%
Edotea triloba		102	51	1.3%	95.6%
Xanthidae	22	59	40	1.1%	96.6%
Gammaridae		65	32	0.8%	97.5%
Scolecopides viridis	16	48	32	0.8%	98.3%
Parapluestes aestuarius	48		24	0.6%	98.9%
Nereis succinea	16	5	11	0.3%	99.2%
Hypaniola florida	5	11	8	0.2%	99.4%
Neomysis americana	5	11	8	0.2%	99.6%
Streblospio benedicti	11		5	0.1%	99.8%
Melita nitida		5	3	0.1%	99.9%
Nemertea		5	3	0.1%	99.9%
Rhithropanopeus harrisi		5	3	0.1%	100.0%
Totals	1243	6437	3840		

Taxon	2 _o channel stations				
	Upper	Lower	Mean	% total	Cum % total
Oligochaeta	1937	1222	1580	77.1%	77.1%
Chironomidae	452	118	285	13.9%	91.1%
Nereis succinea	172	16	94	4.6%	95.7%
Gammarus sp.	38	22	30	1.4%	97.1%
Scolecopides viridis		43	22	1.1%	98.2%
Edotea triloba	11	5	8	0.4%	98.6%
Hypaniola florida	16		8	0.4%	98.9%
Nemertea		11	5	0.3%	99.2%
Ceratopogonidae	5		3	0.1%	99.3%
Chironomidae almyra	5		3	0.1%	99.5%
Corophium sp.	5		3	0.1%	99.6%
Diptera	5		3	0.1%	99.7%
Neomysis americana	5		3	0.1%	99.9%
Xanthidae		5	3	0.1%	100.0%
Totals	2653	1442	2048		

Table 29

Benthic macroinvertebrate mean densities (number / m²) from the tidal river, 2_o channels, and 2_o guts of the St. Jones River portion of the DNERR area, all seasons combined (summer and fall 1994, and spring 1995).

Taxon	Tidal river stations				
	Upper	Lower	Mean	% total	Cum % total
Oligochaeta	1302	1335	1319	34.9%	34.9%
Chironomidae	1765	118	942	24.8%	59.8%
Corophium sp.	1103	11	557	14.7%	74.5%
Edotea triloba	226	135	180	4.8%	79.3%
Neomysis americana	318	27	172	4.6%	83.8%
Ilyanassa sp.		312	156	4.1%	88.0%
Gammarus sp.	151	16	83	2.2%	90.2%
Gammaridae	145		73	1.9%	92.1%
Polychaeta		135	67	1.8%	93.9%
Bivalvia	5	102	54	1.4%	95.3%
Streblospio benedicti	5	91	48	1.3%	96.6%
Scolecopelides viridis	11	54	32	0.9%	97.4%
Polydora ligni	27	22	24	0.6%	98.1%
Cyathura polita	38		19	0.5%	98.6%
Nemertea	32		16	0.4%	99.0%
Nereis succinea	22	11	16	0.4%	99.4%
Eurypanopeus depressus		16	8	0.2%	99.6%
Caecidotea sp.	11		5	0.1%	99.8%
Isopoda		5	3	0.1%	99.9%
Spionidae	5		3	0.1%	99.9%
Idotea sp.		5	3	0.1%	100.0%
Xanthidae	5		3	0.1%	100.1%
Totals	5172	2395	3781		

Taxon	2 _o gut				
	Upper	Lower	Mean	% total	Cum % total
Oligochaeta	2142	565	1354	58.9%	58.9%
Streblospio benedicti	11	457	234	10.2%	69.1%
Polydora ligni	70	328	199	8.7%	77.8%
Chironomidae	205	16	110	4.8%	82.6%
Scolecopelides viridis	48	124	86	3.7%	86.3%
Gammaridae	124	11	67	2.9%	89.2%
Edotea triloba	75	22	48	2.1%	91.3%
Corophium sp.	5	91	48	2.1%	93.4%
Gammarus sp.	54	32	43	1.9%	95.3%
Cyathura polita	59		30	1.3%	96.6%
Hypaniola florida		27	13	0.6%	97.2%
Polychaeta	22	5	13	0.6%	97.8%
Nemertea	16	5	11	0.5%	98.2%
Neomysis americana	11	5	8	0.4%	98.6%
Ilyanassa sp.		16	8	0.4%	98.9%
Nereis succinea		16	8	0.4%	99.3%
Palaemonetes sp.		11	5	0.2%	99.5%
Chiridotea almyra		5	3	0.1%	99.6%
Eurypanopeus depressus		5	3	0.1%	99.8%
Turbellaria		5	3	0.1%	99.9%
Bivalvia		5	3	0.1%	100.0%
Totals	2842	1754	2298		

Table 29 (continued)

Taxon	2. channel				
	Upper	Lower	Mean	% total	Cum % total
<i>Oligochaeta</i>	5839	737	3288	74.7%	74.7%
<i>Turbellaria</i>	581	59	320	7.3%	82.0%
<i>Neomysis americana</i>	22	301	161	3.7%	85.7%
<i>Gammarus</i> sp.	22	237	129	2.9%	88.6%
<i>Streblospio benedicti</i>	11	183	97	2.2%	90.8%
<i>Corophium</i> sp.		172	86	2.0%	92.8%
Chironomidae	140	11	75	1.7%	94.5%
<i>Nereis succinea</i>	22	108	65	1.5%	96.0%
<i>Polydora ligni</i>	38	65	51	1.2%	97.1%
<i>Edotea triloba</i>	81	16	48	1.1%	98.2%
<i>Scolecopides viridis</i>	32		16	0.4%	98.6%
Sphaeriidae	32		16	0.4%	99.0%
Gammaridae	16	5	11	0.2%	99.2%
Xanthidae	5	11	8	0.2%	99.4%
<i>Hypaniola florida</i>	5	5	5	0.1%	99.5%
<i>Nassarius</i> sp.		11	5	0.1%	99.6%
Nemertea	11		5	0.1%	99.8%
Bivalvia		5	3	0.1%	99.8%
Hirudinea		5	3	0.1%	99.9%
<i>Limulus polyphemus</i>		5	3	0.1%	99.9%
<i>Melita nitida</i>		5	3	0.1%	100.0%
Totals	6857	1943	4400		

oligochaeta (1319), chironomidae (942), *Corophium* sp.(557), *Edotea triloba* (180), *Neomysis americana* (172), *Ilyanassa* sp. (156), and *Gammarus* sp. (83).

In the St. Jones River secondary gut stations (ranked fourth overall), twenty-one taxa were identified, of which seven comprised over 91% of the total catch (Table 29).

Listed in order of decreasing abundance with their mean annual density in n/m^2 , these are: oligochaeta (1354), *Streblospio benedicti* (234), *Polydora ligni* (199), chironomidae (110), *Scolecopides viridis* (86), gammaridae (67), and *Edotea triloba* (48).

In the Blackbird Creek secondary channel stations (ranked fifth overall), fourteen taxa were identified, of which two comprised over 91% of the total catch (Table 28). Listed in order of decreasing abundance with their mean annual density in n/m^2 , these are: oligochaeta (1580) and chironomidae (285).

Within all habitats (tidal river, secondary gut and secondary channel) in both the Blackbird Creek and the St. Jones River, the most abundant taxa was always the oligochaeta, annual mean densities (n/m^2) ranging from 1319 (St. Jones tidal river) to 3288 (St. Jones secondary channel), and which comprised 35 to 77 percent of the total mean annual benthic macroinvertebrate densities collected (Tables 28 and 29).

The three most abundant taxa in the tidal river stations of both portions of the reserve were identical, being oligochaeta, chironomidae, and *Corophium* sp. (Tables 28 and 29). *Gammarus* sp. was in the top 90th percentile of both portions, but the remaining taxa differed. *Cyathura polita* was included in the top 90% in the Blackbird Creek, while in the St. Jones River it was *Streblospio benedicti*, *Corophium* sp., and chironomidae which comprised the remainder of this group.

The secondary channel stations in both portions differed greatly in the taxa comprising at least 90% of the total catch. The oligochaeta and chironomidae together comprised over 91% of the Blackbird creek (Table 28). The St. Jones River, also had oligochaeta and chironomidae in the top 90%, in addition to *Neomysis americana*, *Gammarus* sp., and *Streblospio benedicti*.

Within the Blackbird Creek, the tidal river stations had the highest benthic macroinvertebrate annual mean density (3840 n/m²), which was over 87% higher than the secondary channel stations (2048) (Table 28). The density of oligochaeta (ranked first in abundance within both habitats) was near identical, with the tidal river equal to 1623, and the secondary channel at 1580, a difference of less than 3%. The remainder of the taxa, comprising at least 90% of the total catch, differed with 4 taxa in the tidal river (chironomidae, *Corophium* sp., *Gammarus* sp., and *Cyathura polita*), and only one taxon in the secondary channel (chironomidae).

Within the St. Jones River, the secondary channel stations had the highest annual mean density of benthic macroinvertebrates (4400 n/m²), which was 16% more than the tidal river stations (3781), and 91% greater than in the secondary gut (2298) (Table 29).

Each component of the Reserve system had benthic macroinvertebrate taxa collected exclusively in that portion. For the upper Blackbird creek, these exclusive taxa were: the scud *Parapleustes aestuarius*, dipteran (fly) larvae, ceratopogonidae larvae (no see-ums), and the mud crab *Rhithropanopeus harrisi*. For the lower St. Jones River these exclusive taxa were: the mud snail *Ilyanassa* sp., turbellarian flatworms, bivalves (clams), the mud crab, *Eurypanopeus depressus*, the bloodworm, *Glycera* sp., aquatic sowbugs of the order isopoda, the aquatic sowbug, *Caecidotea* sp., the oyster drill,

Urosalpinx cinera, clamworms of the family spionidae, leaches of the class hirudinea, the aquatic sowbug *Idotea* sp., and the horseshoe crab, *Limulus polyphemus*.

The upper Blackbird Creek represents the lower salinity and the lower St. Jones River the higher salinity portions of the reserve, as based on previously collected data and confirmed in this study. The taxonomic composition of the two components of the reserve reflects this, especially some of the lesser abundant benthic macroinvertebrate taxa, many of which have been identified to the species level, and whose salinity preferences are known. The St. Jones River benthic macroinvertebrate community contains some taxa which prefer higher salinities, such as the bloodworm, *Glycera* sp., the oyster drill *Urosalpinx cinera*, the horseshoe crab, *Limulus polyphemus*, the mud crab, *Eurypanopeus depressus*, and the American oyster, *Crassostrea virginica*. In contrast, the lower salinity preferring ceratopogonid (no see-um) fly larva, the aquatic sowbug, *Cyathura polita* (collected from both portions of the reserve, but in much higher quantities in the upper Blackbird Creek), the scud, *Parapleustes aestuarius*, and the mud crab, *Rhithropanopeus harrisi*, were found within the Blackbird Creek samples.

Parabenthic macroinvertebrates

The parabenthic macroinvertebrate community of the combined upper Blackbird Creek and lower St. Jones River portions of the estuarine reserve, as represented by 28 0.5-meter 500 micron plankton net samples collected over three seasons, contained 13 taxa of four phyla, the annelida, arthropoda, cnidaria, and ctenophora (Table 30). Slightly more taxa were taken in the upper Blackbird Creek (11) portion than the lower St. Jones River (9). Total mean densities ($n/100m^3$) of all taxa for both areas and all seasons was 4247. Two taxa constituted over 93% of the total, with one of them, the opossum

shrimp *Neomysis americana*, being predominant in the collections, with a total mean density of 3807, and was responsible for nearly 90% of the total taxa collected. Another taxa, the isopod *Edotea triloba*, contributed 4% of the total densities collected, with a density of 175. The remaining 11 taxa included five crustaceans, two clamworms, one midge, the horseshoe crab, one leech, and one aquatic earthworm.

The seasonal total mean densities of taxa were higher in the St. Jones River in the fall and spring, due to the relatively high densities of *Neomysis americana*, especially in the fall. The total mean densities (n/100m³) for all taxa within each season, for the St. Jones and Blackbird areas were respectively, summer 578 and 719, fall 21,210 and 317, and the spring 643 and 195.

Observed but not counted were truly planktonic taxa such as the sea nettle jellyfish (*Chrysaora quinquecirrha*) and sea walnut comb jellies (*Mnemiopsis leidyi*) in the St. Jones River samples, which are indicative of higher salinity waters of the estuary. The sea nettle was not observed in the lower salinity waters of the Blackbird Creek study area, although unidentified jellyfish and sea walnuts were.

Taxa taken in both the parabenthic and benthic macroinvertebrate collections include the opossum shrimp, *Neomysis americana*, the scuds, *Corophium* sp. and *Gammarus* sp., midge larvae of the family chironomidae, the aquatic sowbug, *Edotea triloba*, the grass shrimp, *Palaemonetes* sp., and the clamworm, *Nereis succinea*.

Parabenthic taxa that were not found in the benthic samples included the fish parasites *Lironeca ovalis* (an isopod or aquatic sowbug) and the fish louse, *Argulus* sp.

Only two parabenthic macroinvertebrate taxa were uniquely collected in a component of the reserve. The upper Blackbird Creek had one taxa, the fish louse, *Argulus* sp. The lower St. Jones River also had one unique taxa, the horseshoe crab, *Limulus polyphemus*.

Waterbirds

There are some distinct differences in habitat between the Blackbird Creek and St. Jones Estuarine Research Reserve areas that affect the avian species compositions between the two sites. Two groups of birds that are dependent on wetlands and/or open water habitats are compared for the estuaries: wading birds and shorebirds.

The abundance and diversity of avian species in all categories is actually much higher than indicated on the data forms, as these data were collected by point count for limited periods of time. Other species of interest that were not tabulated in the data forms will be discussed where appropriate. Survey data for Blackbird Creek and St. Jones River are presented in Appendix E.

Blackbird Creek

The Blackbird Creek study site consists of a fresh to brackish tidal system. A small amount of typical salt marsh occurs in the vicinity of Taylor's Bridge. Upstream from this location, there are some emergent marshes along the edges of Blackbird Creek. Much of the upper estuary is characterized by scrub/shrub wetland with closely-bordering wooded wetlands and uplands. There is a limited area of mud flat that is exposed at low tide approximately

one-half mile upstream from Taylor's bridge. Most of the waterway is shallow and slow-moving. The Delaware Bay shoreline is not included in the Blackbird Creek Estuarine Research Reserve.

Because of the character of the Blackbird Creek estuary, the avian species included many passerines, both residents and migrants, that utilize the scrub/shrub wetlands and the wooded uplands and wetlands, such as scarlet tanager, yellow warbler, common yellowthroat, and Carolina wren. Some waterfowl were observed, such as wood duck, mallard, and Canada goose. Several raptor species were observed, included wintering northern harriers, sharp-shinned and red-tailed hawks, and a pair of breeding bald eagles, which were observed successfully fledging one young. Red-winged blackbirds are extremely plentiful in all seasons along the length of the creek, possibly the reason for the Estuary's name.

Very few shorebirds were observed, due to limited appropriate habitat. A limited number of peeps were observed during migration in the area of the mud flats east of Taylor's Bridge. No open water species were observed, as there was no suitable habitat for them.

Wading Birds

Seven species of wading birds were observed in the Blackbird Creek Estuary during the point counts (Table 31). These were cattle egret, glossy ibis, great blue heron, great egret, green-backed heron, night heron (species undetermined), and snowy egret. The most commonly-observed species were great blue heron and snowy egret, and the sightings of all waders increased going downstream.

TABLE 31

DNERR Avian Community Survey - Blackbird Creek: WADING BIRDS

	Observation Point	CAEG	GLIB	GTBH	GREG	GRBH	?CNH	SNEG
1	Beaver Brook N	-	-	-	-	-	-	-
2	Beaver Brook S	5/31/95: 2	-	-	-	-	-	-
3	Dead Tree Point	-	-	-	-	-	-	-
4	Black Snake Point	-	-	8/3/94: 1 4/25/95: 1 5/31/95: 1	4/25/95: 1	-	-	-
5	Blackbird Land. East	-	-	6/21/94: 1	-	4/24/95: 1	8/3/94: 1	6/6/94: 3
6	Blackbird Land. West	-	-	-	-	-	-	6/6/94: 2 4/24/95: 2
7	Odessa Campgrd.	-	-	-	-	-	-	6/6/94: 1
8	Harvey Farm	6/21/94: 4	-	10/25/94: 1	8/3/94: 1	-	-	6/21/94: 1
9	Cabin Point	-	-	8/3/94: 1 10/25/94: 5	-	-	-	-
10	Kershaw Road	-	-	8/3/94: 2 10/25/94: 1 5/31/95: 2	8/3/94: 2	-	-	6/21/94: 1 5/31/95: 2
11	Taylor's Bridge North	-	-	10/25/94: 1 5/31/95: 1	4/24/95: 15 5/31/95: 1	-	-	6/6/94: 2 5/31/95: 2
12	Taylor's Bridge South	-	4/24/95: 2	6/21/94: 1 8/3/94: 1	6/21/94: 1 4/24/95: 1	-	-	6/6/94: 2 4/24/95: 1 5/31/95: 4

A.O.U. Abbreviations Used in Tables 31-34

Wading Birds:

GTBH	great blue heron
GREG	great egret
SNEG	snowy egret
CAEG	cattle egret
GRBH	green-backed heron
GLIB	glossy ibis
?CNH	black- or yellow-crowned night heron

Shorebirds:

GRYE	greater yellowlegs
WILL	willet
SPSA	spotted sandpiper
SAND	sanderling
SBDO	short-billed dowitcher
COSN	common snipe
REKN	red knot
DUNL	dunlin
BBPL	black-bellied plover
RUTU	ruddy turnstone
KILL	killdeer

Shorebirds

Four shorebird species were observed, including greater yellowlegs, killdeer, spotted sandpiper, and mixed groups of peeps (the small sandpipers) including least sandpiper, semi-palmated sandpiper, and western sandpiper (Table 32). The most common species was the greater yellowlegs, observed mainly in spring and fall from Blackbird Landing to Taylor's Bridge.

St. Jones River

The St. Jones River study site is a salt water to brackish tidal system that is composed of Delaware Bay shoreline (including open water and sandy shore), extensive tidal marsh, a managed pool/wetland complex (the Logan Lane Tract), emergent tidal marsh, scrub/shrub wetland, and wooded wetlands and uplands. The great diversity of habitats results in great range of avian species, ranging from open water wintering waterfowl to breeding neotropical migrants.

The Bay shoreline attracted large numbers of shorebirds during migration as well as scoters and other open water waterfowl during the winter. The Logan Lane Tract pool had the highest species count (N= 41) of any observation point in the St. Jones Reserve. The mouth of the St. Jones River at Bower's Beach is also a rich area, with the second highest number of species observed (N = 31). The open salt marsh habitat supports large numbers of marsh wrens, clapper rails, seaside sparrows, and raptors, including wintering harriers and breeding red-tailed hawks. One harrier, a possible breeder, was observed foraging at

TABLE 32**DNERR Avian Community Survey - Blackbird Creek: SHOREBIRDS**

	Observation Point	GRYE	KILL	SPSA	Peep
1	Beaver Brook N	-	-	-	-
2	Beaver Brook S	-	-	-	-
3	Dead Tree Point	-	-	-	-
4	Black Snake Point	-	-	-	-
5	Blackbird Land. East	10/25/94: 1	-	8/3/94: 1	-
6	Blackbird Land. West	-	-	-	-
7	Odessa Campground	10/25/94: 9	5/31/95: 2	-	-
8	Harvey Farm	10/25/94: 3 4/24/95: 1	-	8/3/94: 5	-
9	Cabin Point	10/25/94: 4	10/25/94: 14 1/23/95: 1	-	5/31/95: 4
10	Kershaw Road	-	10/25/94: 1	-	10/25/94: 7 5/31/95: 70+
11	Taylor's Bridge North	-	-	-	-
12	Taylor's Bridge South	4/24/95: 2	6/21/94:1	-	-

observation point 8 (Courthouse Point) on May 26, 1995. As observations were made further upstream, large numbers of breeding red-winged blackbirds were observed.

Wading Birds

Five species of waders were observed in the St. Jones estuary during point counts - glossy ibis, great blue heron, great egret, green-backed heron, and snowy egret. In addition, little blue heron were observed foraging in the managed pool area (Table 33). The most frequently observed species was the great blue heron, followed by snowy egret. The frequency of wader observations was highest in the two pools included in the study: the Morris Farm Pond (obs. pt. 7) and the Logan Lane Tract Pool (obs. pt. 9).

Shorebirds

There were twelve species or categories of shorebirds observed in the estuary, mainly concentrated along the Delaware Bay shoreline, although the willets, which appear to breed in large numbers in the estuary, were observed over the length of the study area (Table 34). The species were black-bellied plover, common snipe, dunlin, greater yellowlegs, killdeer, red knot, ruddy turnstone, sanderling, short-billed dowitcher, willet, peeps (including least sandpiper, semi-palmated sandpiper, and western sandpiper), and mixed flocks of shorebirds. The largest numbers of shorebirds were observed during May, the primary migration season, with smaller numbers of the migrants scattered through the summer and early fall.

Many shorebirds (as well as waders, gulls, and black skimmers) were observed using the

TABLE 33

DNERR Avian Community Survey - St. Jones River: WADING BIRDS

	Observation Point	CAEG	GLIB	GTBH	GREG	GRBH	7CNH	SNEG
1	Branch Bridge	-	-	-	-	-	-	-
2	Woody Town	-	-	6/7/94: 1	-	-	-	-
3	Rte.113 Bridge	-	-	-	-	6/7/94: 1	-	-
4	Boardwalk E	-	-	-	-	-	-	6/7/94: 2
5	Boardwalk W	-	-	10/26/94: 1	-	-	-	-
6	Morris Farm Creek	-	-	-	-	-	-	-
7	Morris Farm Pond	-	1/25/95: 2 4/22/95: 1 5/26/95: 1	6/22/94: 1 1/25/95: 3 4/22/95: 2 5/26/95: 1	-	-	-	-
8	Courthouse Point	-	-	10/26/94: 1 1/25/95: 1	-	-	-	-
9	Logan Tract Pool	-	8/2/94: 21	6/7/94: 2 10/26/94: 2 1/25/95: 1	6/7/94: 1 10/26/94: 4 4/22/95: 4 5/26/95: 1	-	-	6/7/94: 10 8/2/94: 4
10	Logan Tract Beach	-	-	10/26/94: 2	-	-	-	4/22/95: 2 5/26/95: 1
11	Bower's Beach	-	-	8/3/94: 3 10/26/94: 1 1/25/95: 1	-	-	-	8/2/94: 3

TABLE 34**DNERR Avian Community Survey - St. Jones River: SHOREBIRDS**

	Observation Point	BBPL	COSN	DUNL	GRYE	KILL
1	Branch Bridge	-	-	-	10/26/94: 1 4/22/95: 2	-
2	Woody Town	-	-	-	-	-
3	Rte.113 Bridge	-	-	-	-	-
4	Boardwalk E	-	-	-	-	-
5	Boardwalk W	-	-	-	-	-
6	Morris Farm Creek	-	-	-	-	-
7	Morris Farm Pond	-	4/22/95: 1	-	5/26/95: 1	6/22/94: 1
8	Courthouse Point	-	-	-	-	6/7/94: 1
9	Logan Tract Pool	6/7/94: 1	-	-	8/2/94: 1	6/7/94: 1
10	Logan Tract Beach	-	-	6/7/94: 1 5/26/95: 330	8/2/94: 1	-
11	Bower's Beach	-	-	5/29/95: 1	8/2/94: 3	-

TABLE 34**(Continued)****DNERR Avian Community Survey - St. Jones River: SHOREBIRDS**

	Observation Point	REKN	RUTU	SAND	SBDO	SPSA
1	Branch Bridge	-	-	-	-	-
2	Woody Town	-	-	-	-	-
3	Rte.113 Bridge	-	-	-	-	-
4	Boardwalk E	-	-	-	-	-
5	Boardwalk W	-	-	-	-	-
6	Morris Farm Creek	-	-	-	-	-
7	Morris Farm Pond	-	-	-	-	-
8	Courthouse Point	-	-	-	-	-
9	Logan Tract Pool	-	-	-	8/2/94: 200+	-
10	Logan Tract Beach	8/2/94: 41	6/7/94: 1	10/26/94: 8	8/2/94: 1	-
11	Bower's Beach	8/2/94: 150 5/26/95: 4	5/26/95: 15	10/26/94: 30	-	-

TABLE 34

(Continued)

DNERR Avian Community Survey - St. Jones River: SHOREBIRDS

	Observation Point	WILL	Peep	Mixed flock (shorebirds)	-	-
1	Branch Bridge	4/22/95: 1	-	-		
2	Woody Town	6/7/94: 4 6/22/94: 3 4/22/95: 4 5/26/95: 4	8/2/94: 1	-		
3	Rte. 113 Bridge	-	-	-		
4	Boardwalk E	-	-	-		
5	Boardwalk W	4/22/95: 1 5/26/95: 2	-	-		
6	Morris Farm Creek	-	-	-		
7	Morris Farm Pond	6/22/94: 1 4/22/95: 3	-	-		
8	Courthouse Point	-	-	-		
9	Logan Tract Pool	6/7/94: 1 6/22/94: 1 5/26/95: 3	8/2/94: 400+ 5/26/95: 6	-		
10	Logan Tract Beach	8/2/94: 1	8/2/94: 14 10/26/94: 3 1/25/95: 200+ 5/26/95: 3300	-		
11	Bower's Beach	6/22/94: 8 8/2/94: 5 4/22/95: 14 5/26/95: 6	5/26/95: 280	5/26/95: 90		

shoreline of the Logan Lane Tract. The outlets of the small tidal creeks that resulted from the impoundment dike breaks seem particularly attractive to all species. Because these areas are fairly inaccessible, the birds are largely undisturbed. However, observations of species numbers and composition, as well as spatial and temporal distribution, were not possible in the course of this study. This is an area to investigate further.

Reserve Overview

Wading bird species and numbers were comparable between the two Reserve estuaries, although the habitats differed. In the Blackbird Creek DNERR site, the largest numbers of waders were observed in the emergent marshes bordering the creek, while the largest numbers in the St. Jones River DNERR site were observed in the pools of the Morris Farm Pond (#7) and the Logan Lane Tract Pool (#9). While other survey data just for wading birds at our observation points in these estuaries are not available, the species compositions and numbers seemed to be within normal ranges.

As an indication of species diversity, the number of species observed are shown against the number of visits (number of species/visits to observation points) in Tables 35 and 36. On this basis the two reserve components and most observation points are comparable. The greatest number of species/visits were observed near the mud flats (Harvey Farm and Kershaw property) on Blackbird Creek and in the pools on the St. Jones River. A summary of avian species occurrence is given in Table 37.

There is very little shorebird habitat in the Blackbird DNERR, consisting of a mud flat that is exposed at low tide upstream from Taylors Bridge. Small numbers of shorebirds

TABLE 35**DNERR Avian Community Survey - Blackbird Creek**

<u>Observation point</u>	<u>No. Of spp. (6/94 - 5/95)</u>	<u>Ave. sp/visit</u>
1. Beaver Brook North	15 (7 visits)	2.1
2. Beaver Brook South	11 (6 visits)	1.8
3. Dead Tree Point (Collins Farm east)	20 (6 visits)	3.3
4. Black Snake Point (Collins Farm west)	23 (6 visits)	3.8
5. Blackbird Landing East	28 (7 visits)	4.0
6. Blackbird Landing West	26 (7 visits)	3.7
7. Odessa Campground	15 (7 visits)	2.1
8. Harvey Farm	28 (5 visits)	5.6
9. Cabin Point (Kershaw property)	24 (6 visits)	4.0
10. Kershaw Road (Kershaw property)	34 (6 visits)	5.7
11. Taylor's Bridge North	19 (7 visits)	2.7
<u>12. Taylor's Bridge South</u>	<u>21 (7 visits)</u>	<u>3.0</u>
AVERAGE SPP./ VISIT	3.4	

TABLE 36

DNERR Avian Community Survey - St. Jones River

<u>Observation point</u>	<u>No. Of spp. (6/94 - 5/95)</u>	<u>Ave. sp/visit</u>
1. Branch Bridge Road	19 (6 visits)	3.2
2. Woody Town Road	18 (6 visits)	3.0
3. Route 113 Bridge	12 (6 visits)	2.0
4. Boardwalk East	21 (6 visits)	3.5
5. Boardwalk West	18 (6 visits)	3.0
6. Morris Farm Creek	15 (5 visits)	3.0
7. Morris Farm Pond	25 (5 visits)	5.0
8. Courthouse Point	21 (6 visits)	3.5
9. Logan Tract Pond	41 (7 visits)	5.9
10. Logan Tract Beach	28 (7 visits)	4.0
<u>11. Bower's Beach</u>	<u>31 (6 visits)</u>	<u>5.2</u>
AVERAGE SPP./ VISIT	3.8	

TABLE 37

Based on surveys conducted 5/94 thru 6/95
 - species in bold type are listed in DE's Animal Species of Conservation Concern,
 DE N.H.I. Program, November 1995

BIRD SPECIES	NHI STATUS	BLACKBIRD CREEK	ST. JONES RIVER
American Black Duck	S4B		•
American Coot	S1B, S2N		•
American Crow	S5	•	•
American Goldfinch	S5	•	•
American Robin	S5	•	•
Bald Eagle	S1B, S2N	•	•
Barn Swallow	S5	•	•
Belted Kingfisher	S3		•
Black-bellied Plover	S4N		•
Black Skimmer	S1B		•
Black Vulture	S2B	•	•
Blue Jay	S5	•	•
Blue-winged Teal	S3B		•
Boat-tailed Grackle	S4	•	•
Canada Goose	S5N, S3B	•	•
Carolina Chickadee	S5	•	•
Carolina Wren	S4	•	•
Cattle Egret	S1B	•	•
Chimney Swift	S5B		•
Clapper Rail	S5		•
Common Grackle	S5	•	•
Common Merganser	S3N		•
Common Snipe	S3N		•
Common Tern	S1B, S3N	•	•
Common Yellowthroat	S5B	•	•
Double-crested Cormorant	S1B, S2N	•	•
Downy Woodpecker	S5		•
Dunlin	S3N	•	•
Eastern Blue Bird	S4	•	•
Eastern Kingbird	S5B	•	•
Eastern Meadowlark	S3	•	•
Eastern Wood-Pewee	S4B	•	•
Fish Crow	S5	•	•
Forster's Tern	S1B, S2N	•	•
Glossy Ibis	S1B	•	•
Great Black-backed Gull	S1B, S5N	•	•
Great Blue Heron	S2B	•	•
Great Crested Flycatcher	S5B	•	•
Great Egret	S1B	•	•
Great Horned Owl	S5	•	•
Greater Yellowlegs	S3N	•	•
Green-backed Heron	S5B	•	•
Green-winged Teal	S4N	•	•
Grey Catbird	S5	•	•
Hairy Woodpecker	S3	•	•
Herring Gull	S3B, S5N	•	•
House Wren	S5B	•	•
Indigo Bunting	S5B	•	•
Killdeer	S5B	•	•

TABLE 37 CONT.

BIRD SPECIES	NHI STATUS	BLACKBIRD CREEK	ST. JONES RIVER
Laughing Gull	S3B, S4N	.	.
Least Tern	S1B, S2N	.	.
Mallard	S5B	.	.
Marsh Wren	S4B	.	.
Mockingbird	S5	.	.
Mourning Dove	S5	.	.
Night Heron sp.	S1B, S2B	.	.
Northern Bobwhite	S5	.	.
Northern Cardinal	S5	.	.
Northern Flicker	S5	.	.
Northern Harrier	S1B, S4N	.	.
Northern Pintail	S4N	.	.
Northern Shoveler	SHB, S4N	.	.
Orchard Oriole	S4B	.	.
peeps	n.a.	.	.
Pileated Woodpecker	S3	.	.
Purple Martin	S5B	.	.
Red Head	S2N	.	.
Red Knot	S2N	.	.
Red-bellied Woodpecker	S5	.	.
Red-breasted Merganser	S4N	.	.
Red-eyed Vireo	S5	.	.
Red-tailed Hawk	S5	.	.
Red-winged Blackbird	S5	.	.
Ring-billed Gull	S5N	.	.
Ruby-throated Hummingbird	S5B	.	.
Ruddy Duck	S2N	.	.
Ruddy Turnstone	S2N	.	.
Rufous-sided Towhee	S5B, S3N	.	.
Sanderling	S2N	.	.
Savannah Sparrow	S4N	.	.
Scarlet Tanager	S5B	.	.
Seaside Sparrow	S3	.	.
Sharp-shinned Hawk	S3N	.	.
Sharp-tailed Sparrow	S3B, S1N	.	.
shore birds - mixed flocks	n.a.	.	.
Short-billed Dowitcher	S3T	.	.
Snow Goose	S5N	.	.
Snowy Egret	S1B	.	.
Song Sparrow	S5	.	.
Spotted Sandpiper	SU	.	.
Swamp Sparrow	S3B, S4N	.	.
Tree Swallow	S4B	.	.
Tufted Titmouse	S5	.	.
Turkey Vulture	S5B	.	.
White-crowned Sparrow	S4N	.	.
White-eyed Vireo	S5B, S2N	.	.
White-throated Sparrow	S5N	.	.
Willet	S4B	.	.
Wood Duck	S1N, S3B	.	.
Wood Thrush	S5	.	.
Yellow-billed Cuckoo	S4B	.	.
Yellow-rumped Warbler	S5N	.	.
Yellow Warbler	S4B	.	.

were observed here, but most migrants in this area seem to be concentrated along the Delaware Bay shoreline, which is not included in the Blackbird Creek DNERR. Large numbers of shorebirds were observed in the St. Jones DNERR, concentrated along the Bay shore of the Logan Lane Tract and at Bowers Beach. Many shorebirds were also observed in the Logan Lane Tract Pool at low tide. Other shorebird surveys have been conducted in the general area and species composition and abundance seem to agree with these surveys. However, direct comparisons are difficult to make.

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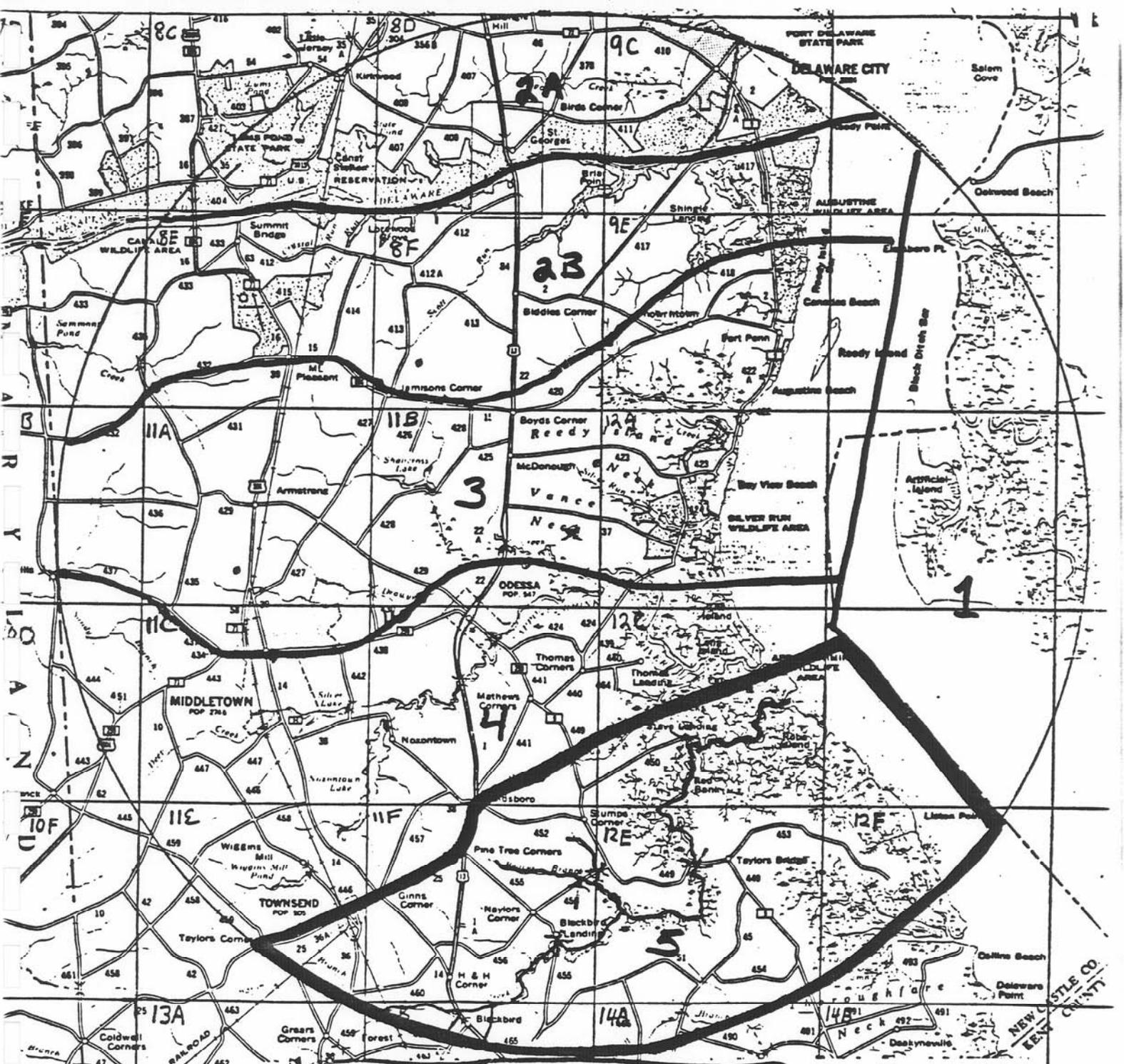
Meta Little - Delmarva Ornithological Society Bombay Hook Christmas Bird Count. Explanation of data collection and survey habitat in Area 8.

Richard C. McCorkle - Gap Analysis Project Biologist, U.S. Fish and Wildlife Service, DE Bay and Estuary Project. Explanation of GAP work in the Blackbird estuary.

Winston J. Wayne - Delmarva Ornithological Society Christmas Bird Count Committee Chair. CBC records and suggestions.

Thomas Whittendale - DNREC Waterfowl Biologist, Delaware DNREC, Division of Fish and Wildlife. Accounts of Delaware waterfowl surveys.

Appendix A



— Blackland Creek
 X — Birds found extensively

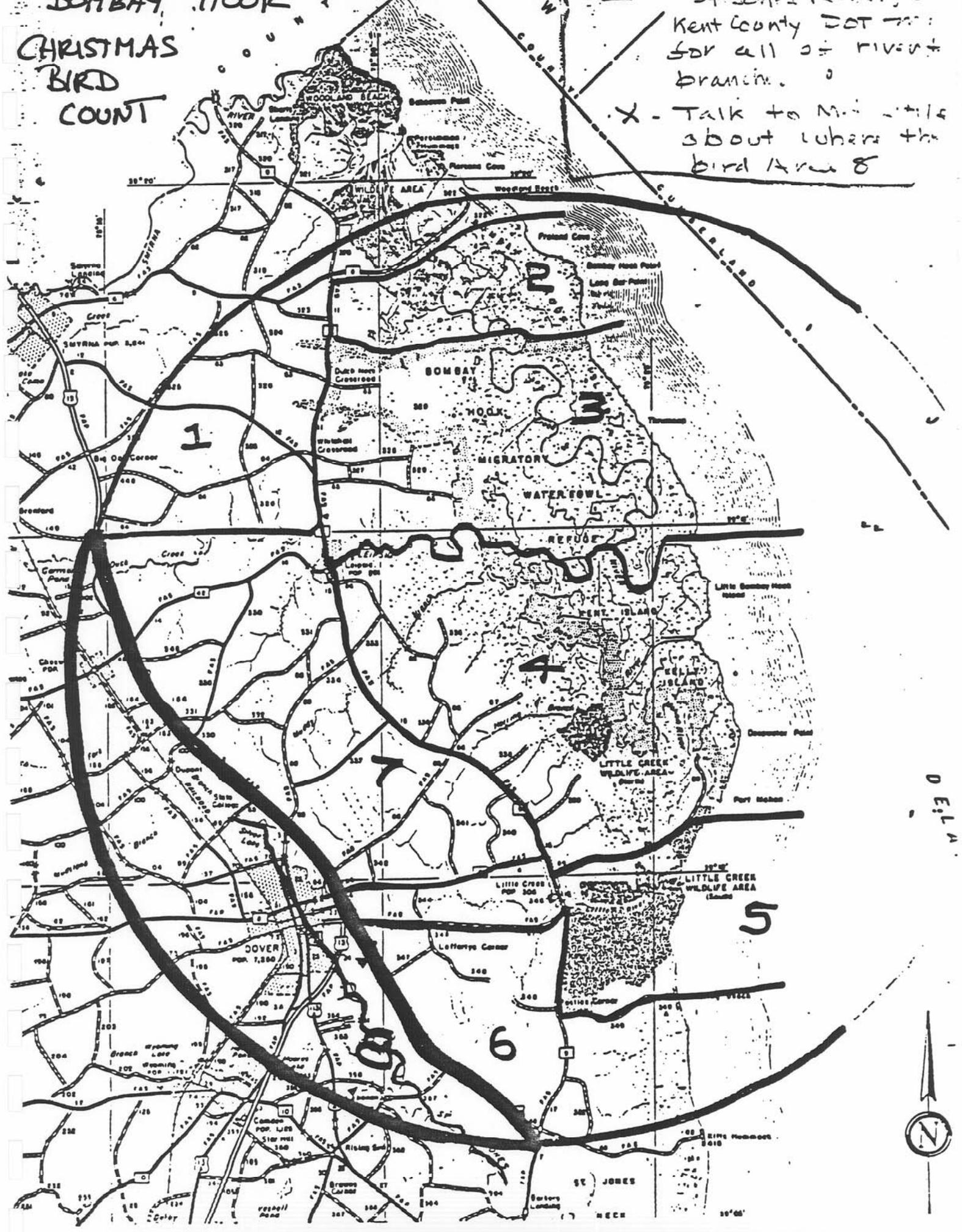
Middletown Christmas Count



DOMBAY, MOOK
CHRISTMAS
BIRD
COUNT

St. Jones River, St.
Kent County DOT for
for all of river +
branches.

X - Talk to Mr. [unclear]
about where the
bird Area 8



DELA.



Appendix B

Delaware Natural Heritage Program Ranking System

Delaware Natural Heritage Program utilizes the heritage ranking scheme developed by The Nature Conservancy. This ranking system is used by all Natural Heritage Programs, The Nature Conservancy, Conservation Data Centers and their network cooperators worldwide. Heritage ranks are assigned to all potentially trackable zoological components found within the state of Delaware. Each species is given a state rank to reflect the degree of rarity within the state of Delaware, and a global rank to indicate degree of rarity worldwide. In general, animal ranks are determined by the number of known occurrences (or populations) of a particular species as determined by reproductive evidence through field investigations by knowledgeable individuals. These ranks are then used to prioritize conservation efforts to provide long-term protection for our most threatened animals. The following are definitions of both the state and global ranking system. Some ranks do not appear within this document but are regularly used by the Delaware Natural Heritage Program.

GLOBAL RANK

- G1** Imperiled globally because of extreme rarity (5 or fewer occurrences worldwide) or because of factors which immediately threaten the existence of the species.
- G2** Imperiled globally because of extreme rarity (6 to 20 occurrences) or because of factors which make the species particularly vulnerable to extinction throughout its range.
- G3** A species which is either very rare and local throughout its range (21 to 100 occurrences) or found only locally in a restricted range, or because of some other factor making it vulnerable to extinction throughout its range.
- G4** Apparently secure globally but uncommon in parts of its range.
- G5** Secure on a global basis, but the species may be uncommon on a local basis.
- GH** Historically known with the expectation that it may be rediscovered.
- GX** Species apparently extinct throughout its historic range.
- GU** Species apparently in peril, but status is undetermined.
- G?** Species has not yet been ranked.
- Q** If a taxon is treated as a full species, a "Q" can be added to the global rank to denote its questionable taxonomic assignment.

T Species with a "T" denote that the infraspecific taxon is being ranked differently than the full species.

STATE RANK

S1 Extremely rare within the state (typically 5 or fewer occurrences) or because some factor immediately threatens the future existence of this species within the state.

S2 Very rare within the state (typically 6 to 20 known occurrences). Species is susceptible to becoming extirpated.

S3 Rare to uncommon; typically 21 to 100 known occurrences. S3 species are not immediately threatened with extirpation, but may be if additional populations are destroyed.

S4 Species apparently secure within the state under present conditions.

S5 Species very common throughout the state; demonstrably secure under present conditions.

SU Species status uncertain within the state. Usually an uncommon species which is believed to be of conservation concern but there is inadequate data to determine degree of rarity.

SH Species historically known from the state but populations or reproductive evidence not verified for an extended period of time (usually 15+ years). There are expectations that this species may be rediscovered.

SX Species presumed to be entirely extirpated from the state. All historical locations and/or potential habitat has been inventoried unsuccessfully. There are no expectations that this species will be rediscovered within the state.

SE Exotic (introduced through human influence) within the state; not a part of the native fauna.

SR Reported from the state, but no evidence exists for accepting or rejecting the report.

SRF Reported falsely from the state but this report persists in the literature.

SA A species which occasionally accidentally enters the state.

SC A species which casually enters the state on a periodic basis but there is no evidence of reproduction or of potential reproductive habitat existing within the state.

For long distance migrant animals, a particular species' breeding status may be very different than its nonbreeding status, i.e. a species which winters commonly in Delaware may be a rare breeder within the state. **B** and **N** qualifiers are used to denote breeding and nonbreeding status respectively. For

example, the Northern Harrier (*Circus cyaneus*) is a common winter resident but a very rare breeder and is, therefore, ranked S1B,S4N. A Z qualifier is used to denote species which regularly migrate or winter in Delaware, but do not maintain definable occurrences during such periods. For lepidoptera species, however, a SZB rank can be given for those individuals which regularly migrate through the state, breed, but no individuals survive to maturity.

FEDERALLY LISTED AND CANDIDATE ANIMAL SPECIES OCCURRING IN THE STATE OF DELAWARE

Common and Scientific Name	Federal Concern
Fulvous Whistling Duck (<i>Dendrocygna bicolor</i>)	Category 2
Harlequin Duck (<i>Histrionicus histrionicus</i>)	Category 2
Bald Eagle (<i>Haliaeetus leucocephalus</i>)	Endangered
Northern Goshawk (<i>Accipiter gentilis</i>)	Category 2
Peregrine Falcon (<i>Falco peregrinus</i>)	Endangered
Black Rail (<i>Laterallus jamaicensis</i>)	Category 2
Piping Plover (<i>Charadrius melodus</i>)	Endangered/Threatened
Roseate Tern (<i>Sterna dougallii</i>)	Endangered/Threatened
Black Tern (<i>Chlidonias niger</i>)	Category 2
Loggerhead Shrike (<i>Lanius ludovicianus</i>)	Category 2
Cerulean Warbler (<i>Dendroica cerulea</i>)	Category 2
Henslow's Sparrow (<i>Ammodramus henslowii</i>)	Category 2
Shortnose Sturgeon (<i>Acipenser brevirostrum</i>)	Endangered
Delmarva Fox Squirrel (<i>Sciurus niger cinereus</i>)	Endangered
Sperm Whale (<i>Physeter catodon</i>)	Endangered
Finback Whale (<i>Balaenoptera physalus</i>)	Endangered
Rorqual Whale (<i>Balaenoptera borealis</i>)	Endangered
Blue Whale (<i>Balaenoptera musculus</i>)	Endangered
Humpback Whale (<i>Megaptera novaengliae</i>)	Endangered
Right Whale (<i>Balaena glacialis</i>)	Endangered
Loggerhead Sea Turtle (<i>Caretta caretta</i>)	Threatened
Atlantic Green Turtle (<i>Chelonia mydas</i>)	Endangered/Threatened
Atlantic Hawksbill Sea Turtle (<i>Eretmochelys imbricata</i>)	Endangered
Atlantic Ridley Sea Turtle (<i>Lepidochelys kempii</i>)	Endangered
Leatherback Sea Turtle (<i>Dermochelys coriacea</i>)	Endangered
Bog Turtle (<i>Clemmys muhlenbergii</i>)	Category 2
Northern Diamondback Terrapin (<i>Malaclemys t. terrapin</i>)	Category 2
Hessel's Hairstreak (<i>Mitoura hesseli</i>)	Category 3

Appendix C

Animal species found during 1994 inventory of the St. Jones River*.
Those in boldface represent Species of Special Concern.

* (B = Nesting within study area; M = migrant through study area; W = wintering within study area; a combined rank is given if species equally depends on study area for migratory, breeding or wintering space)

<u>Common name</u>	<u>Scientific Name</u>	<u>Status*</u>
BIRDS		
American avocet	<i>Recurvirostra americana</i>	M
American black duck	<i>Anas rubripes</i>	B
American robin	<i>Turdus migratorius</i>	B
American goldfinch	<i>Carduelis tristis</i>	B
Bald eagle	<i>Haliaeetus leucocephalus</i>	B (nest failed)
Barn swallow	<i>Hirundo rustica</i>	B
Belted kingfisher	<i>Ceryle alcyon</i>	B
Black skimmer	<i>Rynchops niger</i>	B?
Blue jay	<i>Cyanocitta cristata</i>	B
Boat-tailed grackle	<i>Quiscalus major</i>	B
Brown-headed cowbird	<i>Molothrus ater</i>	B
Carolina chickadee	<i>Parus carolinensis</i>	B
Carolina wren	<i>Thryothorus ludovicianus</i>	B
Clapper rail	<i>Rallus longirostris</i>	B
Common grackle	<i>Quiscalus quiscula</i>	B
Common snipe	<i>Gallinago gallinago</i>	?
Common tern	<i>Sterna hirundo</i>	M
Common yellowthroat	<i>Geothlypis trichas</i>	B
Eastern kingbird	<i>Tyrannus tyrannus</i>	B
Eastern wood pewee	<i>Contopus virens</i>	B
European starling	<i>Sturnus vulgaris</i>	B
Fish crow	<i>Corvus ossifragus</i>	B
Forster's tern	<i>Sterna forsteri</i>	M
Glossy ibis	<i>Plegadis falcinellus</i>	M
Great black-backed gull	<i>Larus marinus</i>	M
Great blue heron	<i>Ardea herodias</i>	M\B
Great egret	<i>Casmerodius albus</i>	M
Great crested flycatcher	<i>Myiarchus crinitus</i>	B
Green-backed heron	<i>Buorides striatus</i>	B

Gray catbird	<i>Dumetella carolinensis</i>	B
Herring gull	<i>Larus argentatus</i>	M
Killdeer	<i>Charadrius vociferus</i>	B
Laughing gull	<i>Larus atricilla</i>	M
Least tern	<i>Sterna antillarum</i>	M
Mallard	<i>Anas platyrhynchos</i>	B
Marsh wren	<i>Cistothorus palustris</i>	B
Mourning dove	<i>Zenaida macroura</i>	B
Northern cardinal	<i>Cardinalis cardinalis</i>	B
Northern harrier	<i>Circus cyaneus</i>	M
Red eyed vireo	<i>Vireo olivaceus</i>	B
Red-tailed hawk	<i>Buteo jamaicensis</i>	B
Red-winged blackbird	<i>Agelaius phoeniceus</i>	B
Red knot	<i>Calidris canutus</i>	M
Ring-billed gull	<i>Larus Delawarensis</i>	B
Royal tern	<i>Sterna maxima</i>	M
Ruby crowned kinglet	<i>Regulus calendula</i>	W
Ruddy turnstone	<i>Arenaria interpes</i>	M
Sanderling	<i>Calidris alba</i>	M
Seaside sparrow	<i>Ammodramus maritimus</i>	B
Scarlet tanager	<i>Piranga piranga</i>	B
Sharp-shinned hawk	<i>Accipenser striatus</i>	M
Snowy egret	<i>Egretta thula</i>	M
Song sparrow	<i>Melospiza melodia</i>	B
Tree swallow	<i>Tachycineta bicolor</i>	B
Tufted titmouse	<i>Parus bicolor</i>	B
Turkey vulture	<i>Cathartes aura</i>	B
Yellow-rumped warbler	<i>Dendroica dominica</i>	M
Yellow warbler	<i>Dendroica petechia</i>	B
Willet	<i>Catoptrophorus semipalmatus</i>	B

REPTILES AND AMPHIBIANS

Diamond-backed terrapin	<i>Malaclemys terrapin</i>	B
Northern spring peeper	<i>Hyla crucifer</i>	B
Southern leopard frog	<i>Rana sphenoccephala</i>	B

MAMMALS

River otter	<i>Lutra canadensis</i>	B
Muskrat	<i>Ondatra zibethicus</i>	B
White-tailed deer	<i>Odocoileus virginianus</i>	B

Appendix D

OBTAINING SURVEY INFORMATION

Delmarva Ornithological Society Christmas Bird Count

CBC data is available through
Delmarva Ornithological Society
P. O. Box 4242
Greenville, DE 19807

Christmas Bird Count Committee Chair
Winston J. Wayne
12 Owls Nest Road
Centerville, DE

Delaware Natural Heritage Inventory Program

NHI Zoologist:
Christopher M. Hechscher
Delaware NHI Program
Division of Fish and Wildlife
4876 Hay Point Landing Road
Smyrna, DE 19977
302-653-2880, E-Mail: checkscher@state.de.us

Delaware DNREC Non-game Program Surveys

DNREC Non-game Biologist:
Lisa Gelvin-Innvaer
Delaware DNREC
Division of Fish and Wildlife
4876 Hay Point Landing Road
Smyrna, DE 19977
302-653-2882, E-mail: lgelvin-inn@state.de.us

Delaware DNREC Aerial Waterfowl Survey

DNREC Waterfowl Biologist:
Thomas Whittendale
Delaware DNREC
Division of Fish and Wildlife
4876 Hay Point Landing Road
Smyrna, DE 19977
302-653-2882

Delaware Gap Analysis Project

U.S. Fish and Wildlife Service, Gap Analysis Project Biologist:

**Richard C. McCorkle
DE Bay and Estuary Project
Bombay Hook NWR
RD 1 - Box 146A
Smyrna, DE 19977
302-653-9153**

Appendix E

CODE KEY TO AVIAN DATA TABLES

A adult
ca calling/singing
ct courtship behavior
fe feeding
fg foraging
fl flying
ns at nest
pr preening
si sitting
st standing
sw swimming
y young

ONERR Asian Communities Survey		BLACKBIRD CREEK		DATE		DATE		DATE		DATE		DATE		DATE			
J. Cabin Point				08/06/95		08/21/94		08/03/94		10/25/94		01/23/95		04/24/95		05/31/95	
BIRD SPECIES		NHI STATUS		NUMBER		BEHAVIOR		NUMBER		BEHAVIOR		NUMBER		BEHAVIOR		NUMBER	
American crow	S5																
American robin	S5																
Carolina wren	S4			1	ca												
bald eagle	S1B, S1N																
blue jay	S5			1	ca												
common bobwhite	S5																
common grackle	S5																
common tern	S1B, S3N			3	sl												
double-crested cormorant	S4			1	st												
great blue heron	S2B			1	st												
greater yellowlegs	S3N			4	ca												
killdeer	S5B			14	ca, fg, fl												
mallard	S5B																
marsh wren	S4B			2	sl												
mourning dove	S5			1	ca												
northern flicker	S5			1	ca												
peeps	n.a.																
red-billed woodpecker	S5			1	fg												
red-tailed hawk	S5																
red-winged blackbird	S5			5	fl												
snow goose	S5N			12	sl, fl												
tree swallow	S4B			110	sl												
tufted titmouse	S5																
yellow-billed cuckoo	S4B			1	ca												
6/06/94 survey not conducted at this site																	

DINERR Avian Communities Survey		BLACKBIRD CREEK										
10. Kershaw Road		DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	
BIRD SPECIES		NIH STATUS	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR
American crow	S5		1	st			5	f.o.				
Canada goose	S5N, S3B											
barn swallow	S5		1 A	f.o.								
black vulture	S3B		2	ca								
blue jay	S5						1	fg			15+	ca, fl
common flicker	S5										1	sw
common grackle	S5						2	f.o.				
double-crested cormorant	S4											
ducks - no i.d.	n.a.											
eastern kingbird	S5B		1	ca							1	ca
eastern wood-pewee	S4B						1	ca, f.o.			2	fl, st
fish crow	S5											
great blue heron	S2B		2	fl, st							1	ca
great egret	S2B		2	fl, st							15	fg
grey catbird	S5		2	ca								
gull - unidentified	-						1	fg				
hairy woodpecker	S5										2	ca
indigo bunting	S5B		1	ca, fl								
killdeer	S5B		2+	ca								
marsh wren	S4B		1	sl								
northern cardinal	S5											
orchard oriole	S4B		1	sl								
peeps	n.a.											
red-bellied woodpecker	S5						1	fg			70+	fg
red-tailed hawk	S5						1	f.o.			1	ca
red-winged blackbird	S5											
rufous-sided towhee	S5B, S3N		40	sl, ca, fl			1	f.o.			10+	ca
savannah sparrow	S4N		1	ca			1	ca			4+	ca, sl
sharp-shinned hawk	S3N		80	f.o.								
snow goose	S5N											
snowy egret	S1B		1	fg, fl								
song sparrow	S5		30	fl							30+	fl
tree swallow	S4B		10+	sl, ca								
white-throated sparrow	S5N											

8/06/94 survey not conducted at this site

WINNERR Avian Communities Survey		BLACKBIRD CREEK																							
BIRD SPECIES	NHI STATUS	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR									
		06/06/94	1	f		06/21/94	9	ca, fl	09/03/94	20+ A, Y	1	ca	10/25/94	100	f.o.	01/23/95	46	sw, fg	04/24/95	20+	sl, fl	05/31/95	5+	f.o.	
harm swallow	S5																								
canada goose	S5N, S3B																								
carolina wren	S4																								
common grackle	S5																								
common yellowthroat	S5B																								
corrier's tern	S1B, S3N																								
great blue heron	S2B																								
great egret	S2B																								
mallard	S5B																								
marsh wren	S4B																								
mourning dove	S5																								
northern harrier	S1b, S3N																								
red-winged blackbird	S5																								
seaside sparrow	S3																								
sharp-shinned hawk	S3N																								
snow goose	S5N																								
snowy egret	S1B																								
spotted sandpiper	SZN																								
turkey vulture	S5B																								

DNERR Avian Communities Survey		ST. JONES RIVER									
2. Woody Town Road		DATE		DATE		DATE		DATE		DATE	
BIRD SPECIES	NHI STATUS	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR
American robin	S5										
barn swallow	S5	8	fl	5	fl	10+	fl	2	f.o.	1	ca
boat-tailed grackle	S4	1	el, fl			3	sw, fg	3	el		
clapper rail	S5	2+	ca					1	ca	1	ca
eastern kingbird	S5B			2	fg			1	fg		
great blue heron	S2B	1	st								
gull - unidentified	-										
laughing gull	S3B, S4N					20+	f.o.				
mallard	S5B	1 ma, 2 fe	sw, st	1	ca	3	ca			1	ca
marsh wren	S4B										
northern cardinal	S5										
peeps	n.a.										
red-winged blackbird	S5	8 ma, 1 fe	ca, fl	6 ma, 2 fe	ca, fl	21 ma, 11 fe	fl, ca	11	fl	50+	ca, fl
seaside sparrow	S3	1	el	1	ca						
song sparrow	S5			1	ca						
tree swallow	S4B			3	ca, fg	2	fl			4	ca, fe, pr
willet	S4B	4	fl, st							1	ca
yellow warbler	S4B										
01/25/95 survey not conducted at this site											

DUNNERR Avian Communities Survey		ST. JONES RIVER																		
BIRD SPECIES	NHI STATUS	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	DATE	NUMBER	BEHAVIOR	
3. Route 113 Bridge		06/07/94	5	fl	06/22/94	7	fl, fg	08/02/94	2	fl	10/26/94			01/25/95			04/22/95		05/26/95	
bain swallow	S5								1	fl									2	f.o.
black vulture	S3B								1	ca									1	ca
Carolina wren	S4																		3	f.o.
common grackle	S5																		1	ca
great crested flycatcher	S5B																			
green-backed heron	S5B		1	sl							1	f.o.								
gul - unidentified	-																			
mourning dove	S5																		1	f.o.
red-tailed hawk	S5										1	fl								
red-winged blackbird	S5		21 ma, 6 fe	ca, sl, fl		5 ma, 8 fe	sl, fl, fg		20+ A, Y	fl, ca	28	fl, ca, f.o.						15	ca, f.o.	5 ma, 5 fe
rufous-sided towhee	S5B, S3N																		1	ca
turkey vulture	S5B																		1	f.o.
01/25/95 survey not conducted at this site																				

DNERR Avian Communities Survey		ST. JONES RIVER									
6. Morris Farm Creek		DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE
BIRD SPECIES	NHI STATUS	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR
American crow	S5	2	f.o.								
boat-tailed grackle	S4										
Carolina wren	S4										
clapper rail	S5	2	ca	1	ca						
common yellowthroat	S5B	2	ca	1 Y	f.o.						
double-crested cormorant	S4										
downy woodpecker	S5										
ducks - no i.d.	n.a.	3	f.o.								
gull - unidentified	-	20	f.o.	25	f.o.						
marsh wren	S4B	1	ca	4+	ca						
red-winged blackbird	S5			30+	f.o.						
seaside sparrow	S3	2	ca, sl	2	ca						
sharp-tailed sparrow	S3B, S2N			20	f.o.						
snow goose	S5N										
turkey vulture	S5B										
08/02/94 survey not conducted at this site											
01/25/95 - no birds observed at this site											

DNERR Avian Communities Survey		ST. JONES RIVER											
7. Morris Farm Pond		DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE
BIRD SPECIES	NHI STATUS	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR
American black duck	S4B												
American coot	S2B, S3N												
barn swallow	S5												
blue goose		6	f.o.										
boat-tailed grackle	S4												
Canada goose	S5N, S3B												
common snipe	S3N												
common yellowthroat	S5B	1	ca										
eastern kingbird	S5B	1	fl										
glossy ibis	S2B	1 Y	fg										
great blue heron	S2B												
greater yellowlegs	S3N												
gull - unidentified	-												
herring gull	S3B, S5N	14	f.o.										
killdeer	S5B												
mallard	S5B	1	fl										
marsh wren	S4B	5	sw, fl										
northern harrier	S1B, S3N	2	ca										
northern shoveler	S4N												
red-tailed hawk	S5												
red-winged blackbird	S5	12 ma, 6 fe	fl										
ruddy duck	S2N												
snow goose	S5N												
willet	S4B	1	fg										
yellow warbler	S4B												
06/07/94 survey not conducted at this site													
08/02/94 survey not conducted at this site													

DNERR Avian Communities Survey		ST. JONES RIVER													
BIRD SPECIES	NHI STATUS	06/07/94		06/22/94		08/02/94		10/28/94		01/25/95		04/22/95		05/26/95	
		DATE	NUMBER	DATE	NUMBER	DATE	NUMBER	DATE	NUMBER	DATE	NUMBER	DATE	NUMBER	DATE	NUMBER
		BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER	BEHAVIOR	NUMBER
11. Bowers Beach															
American black duck	S4B														
barn swallow	S5														
black skimmer	S1B														
boat-tailed grackle	S4														
Canada goose	S5N, S3B														
common grackle	S5														
common tern	S1B, S3N														
common yellowthroat	S5B														
double-crested cormorant	S4														
ducks - no i.d.	n.a.														
dunlin	S3N														
great black-backed gull	S1B, S5N														
great blue heron	S2B														
greater yellowlegs	S3N														
herring gull	S3B, S5N														
laughing gull	S3B, S4N														
little tern	S1B, S2N														
mallard	S5B														
northern harrier	S1B, S3N														
peeps	n.a.														
red head	S3N														
red knot	S2N														
red-breasted merganser	S4N														
red-winged blackbird	S5														
ring-billed gull	S5N														
ruddy turnstone	S2N														
sanderling	S3N														
shore birds - mixed flocks	n.a.														
snowy egret	S1B														
tree swallow	S4B														
willet	S4B														
06/07/94 survey not conducted at this site															