1000. Marine Habitats

- 1100. Subtidal
  - 1110. Rock Bottom
    - 1111. Bedrock
    - 1112. Rubble
  - 1120. Unconsolidated Bottom
    - 1121. Cobble
    - 1122. Gravel
    - 1123. Sand
    - 1124. Mud
    - 1125. Organic
  - 1130. Aquatic Bed
    - 1131. Rooted Algal
    - 1132. Drift Algal
    - 1133. Rooted Vascular
    - 1134. Faunal
  - 1140. Reef
    - 1141. Mollusk
    - 1142. Coral
    - 1143. Worm
    - 1144. Artificial
- 1200. Intertidal
  - 1210. Aquatic Bed
    - 1211. Rooted Algal
    - 1212. Drift Algal
    - 1213. Rooted Vascular
  - 1220. Reef
    - 1221. Coral
    - 1222. Worm
  - 1230. Rocky Shore
    - 1231. Bedrock
    - 1232. Rubble
  - 1240. Unconsolidated Shore
    - 1241. Cobble
    - 1242. Gravel
    - 1243. Sand
    - 1244. Mud
    - 1245. Organic

2000. Estuarine Habitats

- 2100. Subtidal Haline
  - 2110. Rock Bottom
    - 2111. Bedrock
    - 2112. Rubble
  - 2120. Unconsolidated Bottom
    - 2121. Cobble
    - 2122. Gravel
    - 2123. Sand
    - 2124. Mud
    - 2125. Organic
  - 2130. Aquatic Bed
    - 2131. Rooted Algal
    - 2132. Drift Algal
    - 2133. Rooted Vascular
    - 2134. Floating Vascular
    - 2135. Faunal
  - 2140. Reef
    - 2141. Mollusk
    - 2142. Worm
    - 2143. Artificial
- 2200. Intertidal Haline
  - 2210. Aquatic Bed
    - 2211. Rooted Algal
    - 2212. Drift Algal
    - 2213. Rooted Vascular
    - 2214. Floating Vascular
  - 2220. Reef

2221. Mollusk
2222. Worm
2230. Streambed
2231. Bedrock
2232. Rubble
2233. Cobble
2234. Gravel
2235. Sand
2236. Mud
2337. Organic
2240. Rocky Shore
2241. Bedrock
2242. Rubble
2250. Unconsolidated Shore
2251. Cobble
2252. Gravel
2253. Sand
2254. Mud
2255. Organic
2260. Emergent Wetland
2261. Persistent
2262. Nonpersistent
2270. Scrub-Shrub Wetland
2271. BLD
2272. NLD
2273. BLE
2274. NLE
2275. Dead
2280. Forested Wetland
2281. BLD
2282. NLD
2283. BLE
2284. NLE
2285. Mixed
2286. Dead

2300. Supratidal Haline
2310. Rock Bottom
2311. Bedrock
2312. Rubble
2320. Unconsolidated Bottom
2321. Cobble
2322. Gravel
2323. Sand
2324. Mud
2325. Organic
2330. Aquatic Bed
2331. Rooted Algal
2332. Drift Algal
2333. Rooted Vascular
2334. Floating Vascular
2340. Emergent Wetland
2341. Persistent
2342. Nonpersistent
2350. Scrub-Shrub Wetland
2351. BLD
2352. NLD
2353. BLE
2354. NLE
2355. Dead
2360. Forested Wetland
2361. BLD
2362. NLD
2363. BLE
2364. NLE
2365. Mixed
2366. Dead

- 2400. Subtidal Fresh
  - 2410. Rock Bottom
    - 2411. Bedrock
    - 2412. Rubble
  - 2420. Unconsolidated Bottom
    - 2421. Cobble
    - 2422. Gravel
    - 2423. Sand
    - 2424. Mud
    - 2425. Organic
  - 2430. Aquatic Bed
    - 2431. Rooted Algal
    - 2432. Drift Algal
    - 2433. Rooted Vascular
    - 2434. Floating Vascular
    - 2435. Aquatic Moss
  - 2440. Reef
    - 2441. Mollusk
- 2500. Intertidal Fresh
  - 2510. Aquatic Bed
    - 2511. Rooted Algal
    - 2512. Drift Algal
    - 2513. Rooted Vascular
    - 2514. Floating Vascular
    - 2515. Aquatic Moss
  - 2520. Streambed
    - 2521. Bedrock
    - 2522. Rubble
    - 2523. Cobble
    - 2524. Gravel
    - 2525. Sand
    - 2526. Mud
    - 2527. Organic
  - 2530. Rocky Shore
    - 2531. Bedrock
    - 2532. Rubble
  - 2540. Unconsolidated Shore
    - 2541. Cobble
    - 2542. Gravel
    - 2543. Sand
    - 2544. Mud
    - 2545. Organic
  - 2550. Emergent Wetland
    - 2551. Persistent
    - 2552. Nonpersistent
  - 2560. Scrub-Shrub Wetland
    - 2561. BLD
    - 2562. NLD
    - 2563. BLE
    - 2564. NLE
    - 2565. Dead
  - 2570. Forested Wetland
    - 2571. BLD
    - 2572. NLD
    - 2573. BLE
    - 2574. NLE
    - 2575. Mixed
    - 2575. Dead

3000. Riverine Habitats

- 3100. Lower Perennial
  - 3110. Unconsolidated Bottom
    - 3111. Gravel
    - 3112. Sand
    - 3113. Mud
    - 3114. Organic
  - 3120. Aquatic Bed

- 3121. Aquatic Moss
- 3122. Rooted Vascular
- 3123. Floating Vascular

3130. Rocky Shore
- 3131. Bedrock
- 3132. Rubble

3140. Unconsolidated Shore
- 3141. Cobble
- 3142. Gravel
- 3143. Sand
- 3144. Mud
- 3145. Organic

3150. Emergent Wetland
- 3151. Nonpersistent

3200. Upper Perennial

3210. Rock Bottom
- 3211. Bedrock
- 3212. Rubble

3220. Unconsolidated Bottom
- 3221. Cobble
- 3222. Gravel
- 3223. Sand
- 3224. Mud

3230. Aquatic Bed
- 3231. Algal
- 3232. Aquatic Moss
- 3233. Rooted Vascular
- 3234. Floating Vascular

3240. Rocky Shore
- 3241. Bedrock
- 3242. Rubble

3250. Unconsolidated Shore
- 3251. Cobble
- 3252. Gravel
- 3253. Sand
- 3254. Mud
- 3255. Organic

3260. Emergent Wetland
- 3261. Nonpersistent

3300. Intermittent

3310. Streambed
- 3311. Bedrock
- 3312. Rubble
- 3313. Cobble
- 3314. Gravel
- 3315. Sand
- 3316. Mud
- 3317. Organic
- 3318. Vegetated

4000. Lacustrine Habitats

4100. Limnetic

4110. Rock Bottom
- 4111. Bedrock
- 4112. Rubble

4120. Unconsolidated bottom
- 4121. Cobble
- 4122. Gravel
- 4123. Sand
- 4124. Mud
- 4125. Organic

4130. Aquatic Bed
- 4131. Algal
- 4132. Aquatic Moss
- 4133. Rooted Vascular
- 4134. Floating Vascular

- 4200. Littoral
  - 4210. Rock Bottom
    - 4211. Bedrock
    - 4212. Rubble
  - 4220. Unconsolidated Bottom
    - 4221. Cobble
    - 4222. Gravel
    - 4223. Sand
    - 4224. Mud
    - 4225. Organic
  - 4230. Aquatic Bed
    - 4231. Algal
    - 4232. Aquatic Moss
    - 4233. Rooted Vascular
    - 4234. Floating vascular
  - 4240. Rocky Shore
    - 4241. Bedrock
    - 4242. Rubble
  - 4250. Unconsolidated Shore
    - 4251. Cobble
    - 4252. Gravel
    - 4253. Sand
    - 4254. Mud
    - 4255. Organic
  - 4260. Emergent Wetland
    - 4261. Nonpersistent

5000. Palustrine Habitats

- 5100. Perennial Water
  - 5110. Rock Bottom
    - 5111. Bedrock
    - 5112. Rubble
  - 5120. Unconsolidated Bottom
    - 5121. Cobble
    - 5122. Gravel
    - 5123. Sand
    - 5124. Mud
    - 5125. Organic
  - 5130. Aquatic Bed
    - 5131. Algal
    - 5132. Aquatic Moss
    - 5133. Rooted Vascular
    - 5134. Floating vascular
  - 5140. Emergent Wetland
    - 5141. Nonpersistent
- 5200. Intermittent or Saturated
  - 5210. Unconsolidated Shore
    - 5211. Cobble
    - 5212. Gravel
    - 5213. Sand
    - 5214. Mud
    - 5215. Organic
  - 5220. Moss-Lichen Wetland
    - 5221. Moss
    - 5222. Lichen
  - 5230. Emergent Wetland
    - 5231. Nonpersistent
    - 5232. Persistent
  - 5240. Scrub-Shrub Wetland
    - 5241. BLD
    - 5242. NLD
    - 5243. BLE
    - 5244. NLE
    - 5245. Dead
  - 5250. Forested Wetland
    - 5251. BLD
    - 5252. NLD

5253. BLE
5254. NLE
5255. Mixed
5256. Dead

6000. Upland Habitats

6100. Supratidal Upland

6110. Rocky Upland

6111. Bedrock
6112. Rubble

6120. Unconsolidated Upland

6121. Cobble
6122. Gravel
6123. Sand
6124. Clay
6125. Loam
6126. Organic

6130. Herbaceous Upland

6131. Grassland
6132. Broad-leaved Herbs

6140. Scrub-Shrub Upland

6141. BLD
6142. NLD
6143. BLE
6144. NLE
6145. Dead

6150. Forested Upland

6151. BLD
6152. NLD
6153. BLE
6154. NLE
6155. Mixed
6156. Dead

6200. Inland Upland

6210. Rocky Upland

6211. Bedrock
6212. Rubble

6220. Unconsolidated Upland

6221. Cobble
6222. Gravel
6223. Sand
6224. Clay
6225. Loam
6226. Organic

6230. Herbaceous Upland

6231. Grassland
6232. Broad-leaved Herbs

6240. Scrub-Shrub Upland

6241. BLD
6242. NLD
6243. BLE
6244. NLE
6245. Dead

6250. Forested Upland

6251. BLD
6252. NLD
6253. BLE
6254. NLE
6255. Mixed
6256. Dead

7000. Perennial Snow and Ice Habitats

7100. Perennial Snowfields
7200. Glaciers

8000. Cultural Land Cover

8100. Developed Upland

8110. Impervious Cover

8111. Paved Lot

8112. Paved Roadway
8113. Large Building
8114. Impervious Complex
8120. Built-up Cover
8121. Commercial or Service Complex
8122. Industrial Complex
8130. Residential Cover
8131. Low Density
8132. Medium Density
8133. High Density
8140. Rocky Cover
8141. Rocky Revetment
8142. Open Quarry
8150. Unconsolidated Cover
8151. Cleared Land
8151. Dirt/gravel Lot
8152. Dirt/gravel Road
8153. Railway Corridor
8154. Mining Operation
8155. Landfill Operation
8160. Herbaceous Cover
8161. Managed Turf
8162. Managed Garden
8163. Managed Old Field
8170. Shrub Cover
8171. Managed Shrubs
8180. Tree Cover
8181. Managed Trees

8200. Agricultural Upland
8210. Rocky Cover
8211. Rocky Revetment
8220. Unconsolidated Cover
8221. Unvegetated Farmland
8230. Herbaceous Cover
8231. Turf
8232. Pasture
8233. Hay Meadow
8234. Crops/Cover Crops
8240. Shrub Cover
8241. Shrub Nursery
8242. Grazed Shrub Upland
8250. Tree Cover
8251. Tree Farm
8252. Orchard
8253. Grazed Wooded Upland

8300. Developed and Managed Wetlands and Water
8310. Impervious Cover
8311. Impervious Bottom
8312. Impervious In-water Structure
8320. Built-up Cover
8321. Pervious In-water Structure
8322. In-water Commercial or Service Complex
8323. In-water Industrial Complex
8324. Shellfish Aquiculture
8325. Finfish Aquiculture
8330. Residential Cover
8331. In-water Residential Complex
8340. Rocky Cover
8341. Rocky Shoreline Structure
8342. Rocky In-water Structure
8350. Unconsolidated Cover
8351. Managed Unconsolidated Bottom
8352. Managed Unconsolidated Shore
8360. Herbaceous Cover
8361. Managed Herbaceous Wetland
8362. Agricultural Herbaceous Wetland

8363. Grazed Herbaceous Wetland
8370. Shrub Cover
8371. Managed Wetland Shrubs
8372. Agricultural Wetland Shrubs
8373. Grazed Shrub Wetland
8380. Tree Cover
8381. Managed Wetland Trees
8382. Agricultural Wetland Trees
8383. Grazed Wooded Wetland

The Proposed Classification

A. Structure and Content

The *NERRS Classification Scheme*, as it is referred to in this section, is intended for use in classifying and inventorying fine-scale data within reserve boundaries. Technical and financial limitations associated with classifying vast areas of land will require the use of automated classification to characterize large watersheds. Thus, watershed-wide (coarse-scale) classes will be determined by the capabilities of that technology to discriminate between cover classes. The NERR Remote Sensing Committee is currently developing appropriate technology protocols to determine course-scale (watershed-wide) classes. The HMCTC expects coarse-scale classes to easily crosswalk with the recommended classification for fine-scale data through the use of a relational table.

The recommended NERRS Classification Scheme consists of a merger of two well-accepted and utilized classification schemes, Cowardin et al. (1979) and Anderson et al. (1976), applied to a five-level, nested hierarchical framework with a strictly numeric heading system. For consistency in terminology, levels 1-4 are adopted from Cowardin et al.: *System* (L1)*, Subsystem* (L2)*, Class* (L3)*,* and *Subclass* (L4). The lowest level, *Descriptor* (L5), was added to facilitate communication and crosswalking with other classification systems. Characterization of land cover by all five levels may be required to realize the objectives of the HMC Initiative (TBD).

There are eight *systems* in the classification. Five wetland and deepwater habitat *systems* (including their associated *subsystems, classes,* and *subclasses*) are adopted directly from Cowardin. A cultural land use *system* and a snow-and-ice habitat *system* are adopted directly from Anderson, and an upland habitat *system* is based on Cowardin (Fig. 1). For the purposes of habitat and land use differentiation in the NERRS classification, *land use* cover types are defined as those modified by mechanical or chemical manipulation more than once per growing season, regularly grazed by livestock, or modified to a condition that prohibits natural community succession (Kutcher et al. 2004). *Habitat* cover types are those in a sustained or reclaimed *natural* state. Even if they are highly influenced by previous or existing historic modifications, cover types should be classified as habitats if they are not regularly modified and in turn exhibit natural successional progression. Furthermore, to encourage an ecological approach in mapping, habitats occurring within broad land use types (e.g. shrublands within parks or residential areas) should be classified as habitats.

For wetland, deepwater and upland habitat *systems*, *System* designation is essentially based on the most influential water source (e.g., *Marine*). *Subsystem* is based on some hydrologic influence on the habitat (e.g., *Intertidal*), *Class* is based on vegetation or substrate structure (e.g., *Forested* or *Rocky Shore*), and *Subclass* is based on vegetation life strategy or particle size (e.g., *Broad-leaved Deciduous* or *Sand*).

The *Upland Habitats system* is based on the Cowardin hierarchy and class breaks for wetland habitats. Two *subsystems* are defined to accommodate NERRS needs. The first, *Supratidal Upland* is defined as any upland occurring in the zone that ranges from the intertidal zone to the storm event log line, and is directly affected by coastal processes such as storm event flooding, salt spray, erosion and coastal winds (FNAI 2004), while *Inland Uplands* constitute all other upland habitats. Five *classes* for *rocky, unconsolidated*, *herbaceous*, *scrub-shrub*, and *forested*

upland habitats parallel Cowardin wetland *classes*: *rocky shore, unconsolidated shore, emergent, scrub-shrub, and forested*, respectively. NERRS *subclasses* are the same as in Cowardin for each respective *class*, except *grasslands/broad-leaved herbaceous* replaces the *persistent/nonpersistent* subdivision for *herbaceous*, and *clay* and *loam* replace *mud* for the *unconsolidated* class.

For the *Cultural Land Use system*, *subsystem* designation is divided between urban and agricultural uses (Anderson Level I), and *class* designation is based on the type of development or agriculture employed in each (Anderson Level II). The Anderson classification was designed to be open ended to allow for further subdivision at regional levels. Anderson offered vague guidelines for a third level, and many state agencies have interpreted those guidelines and applied a third level to their land cover mapping efforts. Perhaps the most crucial subdivision regarding HMC objectives is that of residential property. The HMCTC recommends subdividing the *residential* class by low, med-low, med, med-high, and high-density residential subclasses described by units per acre (RIGIS 1998) for compatibility with NRCS infiltration and runoff modeling, and to facilitate crosswalking with C-CAP datasets. All other cultural subclasses were taken directly from the Ohio Level III land use classification (Schaal 1988), as it closely follows Anderson's guidelines.

The *Snow and Ice Habitat system* is only subdivided once into *Glaciers* and *Perennial Snow subsystems* as adopted from Anderson. No suggestions for further subdivision are offered here.

Descriptors for all data are applied at the fifth level (numbered by two decimal places to allow for 99 possible types within each *subclass*). *Descriptors* are descriptive, defined and well-accepted, common habitat or land use names, preferably previously defined in national or regional scientific literature. A habitat descriptor can characterize a habitat dominated by a single species (e.g., *Atlantic White Cedar Swamp*), by multiple species (e.g., *Pitch Pine-Oak Forest*), or by substrate (e.g., *Inland Sand Barren*). For cultural land use data, *descriptors* may simply be reiterations of the *subclass* or *class*. They will serve to facilitate communication between data providers and users. *Descriptors* will also allow crosswalking between classification systems, since they represent a link that is commonly utilized in the various classification systems of the Reserve System. Each *descriptor* and a standardized detailed definition will be filed and maintained on the intranet to avoid name overlap within the Reserve System. Refer to Table 1 for an example of a *Descriptor* standardized definition.

Modifiers beyond the hierarchy of the classification may be added as fields (columns) to a dataset attribute table to add greater descriptive/analytical detail or to facilitate crosswalking with different classification systems that use other criteria or codes. The HMCTC will recommend, define and provide an active list of appropriate ecological habitat modifier fields (column headings) and modifiers to be posted on the NERR intranet website for system-wide application (Appendix 2). Modifiers will include many of those suggested by Cowardin et al. (1979), which further describe each habitat by dominant species (by scientific name), water regime (and soil moisture), water chemistry (e.g., by salinity classes in ‰) and certain cultural modifications. Water/soil water chemistry modifiers will address concerns regarding differentiation between *salt* and *brackish* estuarine wetland types, while cultural modifiers will enable users to identify historic anthropogenic pressures affecting habitats, with terms such as *Impounded, Diked,* or *Excavated*. Invasive species modifiers are also recommended to identify the presence and percent cover of invasive species within each habitat. Certain modifiers may

be either required or optional for establishing a national inventory baseline, to be determined during methods development at a later date. Any in-system user may present proposals for additions to the system-wide list of modifier fields or modifiers to the HMCTC, where they will be reviewed and added to the official intranet list as appropriate. Site specific modifiers may also be added locally or regionally to allow GIS queries relevant to regional studies, or other scheme class parameters, names, or codes such as *Mesic Uplands* for Florida's FNAI, or *681* for PALIS ID codes in MA water bodies.

B. Amendments to Cowardin

1. Tidal Fresh Habitats

Cowardin et al. (1979) classifies wetlands and deepwater habitats influenced by ocean derived freshwater tides in the *Riverine* system, *Tidal* subsystem. This classification is deficient in addressing the needs of the NERRS in two ways. First, it does not allow for differentiation between subtidal and intertidal habitats, which are clearly discernable in many of our tidal fresh ecosystems, some of which have tide ranges approaching two meters. Second, the Cowardin classification entirely lacks classes for tidal fresh habitat types dominated by persistent emergent and woody vegetation. Furthermore, Cowardin defines estuarine habitats as extending upstream to waters of <0.5‰ salinity during annual low water, which agrees with the Prichard (1967) definition for estuaries. However, more recent functional definitions, which define estuaries as extending to the head of tide (Fairbridge, 1980; Day et al. 1989), better suit NERRS estuary systems with extensive tidal fresh zones, such as those of Hudson River and Chesapeake Bay. To address these issues, the NERRS adaptation modifies Cowardin in the following ways:

- The extent of the *Estuarine* system is redefined as extending upstream and landward to the upper limit of tidal rise during spring tide and mean annual low river flow, to include freshwater wetlands and deepwater habitats flooded by ocean driven tides. The Estuarine system is also extended to include non-tidal wetlands with ocean derived salts >0.5‰, such as dune swales occurring in the supratidal zones of maritime and estuarine coastlines.
- The above allows the *Tidal* subsystem to be moved from the *Riverine* system into the *Estuarine* system.
- The *Tidal* subsystem is then split into *2400. Subtidal Fresh* and *2500. Intertidal Fresh* subsystems with appropriate class divisions.
- The subclass *2551. Persistent Emergent*, and *2560. Scrub-shrub* and *2570. Forested* classes and the appropriate associated subclasses are inserted into *2500. Intertidal Fresh* to address those deficiencies in Cowardin. .
- Original *Subtidal* and *Intertidal* habitats of the *Estuarine* system (those with >0.5‰ salinity) are renamed *2100. Subtidal Haline* and *2200. Intertidal Haline* to differentiate them from tidal fresh subsystems.

2. Estuarine Supratidal Wetlands

Recent literature and scientific investigation has incorporated the use of the term *supratidal* to describe the coastal shore zone from spring high water to the storm *log line*, or the highest reach of storm event water (FNAI 2004). While the *Supratidal Uplands subsystem* (heading 6100 in Appendix 1) will handle the classification of supratidal upland habitats such as dune

grasslands and shrublands, wetlands within the supratidal zone that transiently or permanently contain ocean-derived salts >0.5‰ necessitate expansion of the Cowardin classification to include a *Supratidal Haline subsystem* (heading 2300 in Appendix 1) and appropriate associated *classes* and *subclasses* within the *Estuarine system*. Note that the *Supratidal Haline subsystem* only applies to nontidal *true* wetlands (i.e. those dominated by hydrophytes, containing hydric soils, or submerged or saturated for some time during the growing season [Cowardin et al. 1979]) lying within the supratidal zone, such as dune swales or nontidal ponds that are periodically breached by haline storm water. Under the Cowardin methodology, supratidal upland habitats cannot be classified as estuarine since the *Estuarine* habitat *system* is defined as a wetland and deepwater habitat system. The division of the supratidal zone into estuarine and upland systems will require only a single extra step in analyses, while retaining the well-accepted definitions of the Cowardin system. This addition will not affect the rest of the classification.

3. Palustrine Open Water

Palustrine habitats are essentially all non-tidal persistent freshwater wetlands, and unvegetated and nonpersistent freshwater wetlands that are not in a river channel or lake basin (Cowardin et al. 1979). The NWI has consistently used *Palustrine Open Water* as a subsystem when applying the Cowardin classification to describe small ponds (less than 8 ha and less than 2 m deep at low water) with unknown submergent vegetation or sediment. However, palustrine open water habitats are not officially divided from other palustrine habitats in the Cowardin system. To facilitate cross walking with NWI, the NERRS *Palustrine* system has been subdivided into *Open Water* and *Terrestrial Wetland* subsystems with associated logical grouping of the lower classes. All else remains the same.

4. Faunal Aquatic Bed

The Cowardin classification does not provide a *Faunal* subclass for marine and estuarine aquatic beds. Florida's FNAI classification identifies sponge and octocoral beds, which require that addition. This will not affect the rest of the classification.

5. Algal Aquatic Bed

The Cowardin *subclass Algal* was split into the *subclasses Rooted Algal* and *Floating Algal* to differentiate between the two algal types in the *Marine* and *Estuarine* habitat *systems*.

6. Artificial Reef

Large submerged artificial reefs, such as shipwrecks and discarded bridges, require a special exception to the rule differentiating habitats from cultural land uses because a dominant ecological function is provided by the structure itself, which will likely begin providing habitat for flora and fauna within a single season. Thus, the subclass *Artificial* was inserted into *Subtidal subsystems* of the *Marine* and *Estuarine* habitat *systems*.

7. Cobble and Gravel

The Cowardin *subclass Cobble-gravel* was split into the *subclasses Cobble* and *Gravel* to differentiate between the two unconsolidated types. Each type is defined by particle size in Cowardin et al. (1979).

Conclusions

A. Benefits for the Reserve System

The recommended NERRS Classification Scheme was designed to specifically meet the needs of the Reserve System in providing data users with a valuable tool to address the objectives of the HMC Initiative. It is compatible with existing classification efforts within the system and will allow simple crosswalking with existing datasets. It is also compatible with the finer levels and modifiers of the CMECS and the TNC national classification initiatives due to certain parallel classes and its open ended *modifier* structure. It is fully capable of classifying all cover types, logically organizing all deepwater, wetland, upland habitat and cultural land use data into a seamless dataset. It is effective over the entire geographic extent of the NERRS. It utilizes universally accepted and applied structure and terminology, making it simple to use and useful for communicating data with scientists and non-scientists. It allows crosswalking between coarse-level and fine-level datasets. It allows detailed upland, wetland, and deepwater habitat classification. It can provide a basis for runoff and infiltration modeling. It is compatible with GIS software and with accepted methods of data collection and classification, such as C-CAP/NLCD terrestrial and SAV protocols, and NWI protocol. Finally, the nested hierarchy and numeric heading system facilitate data analysis at numerous ecologically significant levels of interest and provide the intuitive utility of a multinomial key.

The classification system as presented will address the management issues identified by the reserve system and build upon NERR site-based GIS capacity, implementation of SWMP phase II methodologies, and will be facilitated by NOAA's priority on acquisition and improvement of remotely sensed imagery to address estuarine and near shore habitat issues.

B. Limitations of the Classification System

The primary caveat regarding geospatial data classification is that each classification system is designed for a particular set of uses. No single classification is ever likely to meet the host of demands required by all geospatial data users. The NERRS scheme was designed specifically to meet the needs of the NERRS. The scheme requires a cursory knowledge of the Cowardin and Anderson system definitions and terminology. Of the two, the Cowardin terminology is the more specialized, but as a group comprised primarily of estuarine scientists, the NERRS will generally be familiar with the term definitions. Otherwise, *Classification of Wetland and Deepwater Habitats of the United States* (Cowardin et al. 1979) defines all terms and class breaks, and is available on-line through the US Fish and Wildlife Service. Anderson terminology is defined in *A land cover and land use classification system for use with remote sensor data* (Anderson et al. 1976), which is available on-line from the USGS.

Just as a classification scheme is designed to meet the needs of the user, technology also must be applied to meet the needs of the user (Wang, personal communication). The NERRS

classification scheme does not necessarily allow for all classification limitations inherent in technology for high resolution automated classification, but instead is intended to address objectives that require detail and comprehensiveness. The interpretation of multiple data types plus ground-truthing may be necessary to classify land cover types to the lower levels, depending on how newer technology serves the needs of the Reserve System. The Cowardin and Anderson classifications were originally intended for photointerpretation and ground truthing, which may still be the most appropriate methodology for inventorying fine-scale geospatial data in the Reserve System at this time.

For unsupervised coarse scale classification (such as in the C-CAP effort), the Anderson classification has been superceded by classes limited to those discernable through automated classification. Computer generated classes tend not to fall at one set logical level, while many non-discernable classes written into the Anderson classification go unutilized. (*)A C-CAP based classification for coarse scale data will meet the Reserve System's needs for watershed data and can be easily crosswalked into the NERRS classification for analyses requiring comparisons to fine-scale data.

Subterranean habitat classes are not included in the NERRS classification. Mapping of subterranean habitats requires different data collection technologies and methods, and may require a separate GIS layer due to overlap of terrestrial and subterranean habitats. A separate data layer with a suitable subterranean classification system may be most appropriate for this application, which is currently being considered beyond the scope of this project. Any proposals for a standardized system-wide classification and monitoring protocol for subterranean habitats should be brought to the HMC Committee.

While the NERRS classification is based on two classification systems that have been designed and tested to be nearly comprehensive, there remains a possibility that a class occurring within the reserve system has been overlooked. Any deficiency in the classification should be brought to the attention of the HMCTC Classification Subgroup for verification and amendment.

The above is excerpted from: *A Recommendation for a Comprehensive Habitat and Land Use Classification System for the National Estuarine Research Reserve System*, by Thomas E. Kutcher, Nina H. Garfield, and Kenneth B. Raposa