RESULTS FOR AQUATIC SYSTEMS[*1]

Modifications to Standard Method

The CBY aquatic ecosystem analysis was done before the standard methodology outlined in the chapter Planning Methods for Freshwater Aquatic Ecosystems and Networks was developed. Much of the analysis and thinking developed during the CBY plan contributed to this methodology; however you will notice certain pieces of the standard methodology missing or done differently in the CBY Plan. The original CBY methods are explained in detail below. Notable differences are as follows:

Aquatic Ecological Systems: In CBY the Aquatic Ecological Systems were not developed using a statistical clustering of multiple scaled watersheds based on underlying ecological land unit (ELU) types. Rather, they were delineated in a much more interactive manner by Jen Perot, the GIS Analyst/Freshwater Ecologist for this part of the project. Jen Perot looked for hydrologically connected stream reaches sharing the same four macrohabitat attributes: size, connectivity, gradient, and hydrologic/chemical regime. By identifying repeating patterns of reaches sharing these four attributes, she was able to group the reaches into 12 generalized system types. Although different system types were not defined specifically within each river size class, the resultant system types do generally represent rivers within a narrow size range. For example, system 12 includes only very large rivers, while other system types represent headwaters (1, 2, 7) and still others represent headwaters to creek/small river sizes (3, 5, 6, 8, 9, 10, 11). The system types were reviewed and modified by experts and served as our coarse-filter aquatic ecosystem targets.

Condition Analysis: The CBY condition analysis was very similar to the standard method. Both a watershed and reach level GIS condition analysis were performed. During these GIS analyses, the data was also summarized using PCA ordination within system types according to the three impact areas of landcover/roads, dams and drinking water, and point sources. An expert interview and review process to highlight areas of aquatic biological significance was also performed. CBY departed from the standard method in that 1) only one size of watershed was used in the GIS watershed ranking classification, 2) no formal non-system relative ranking was performed although various non-relative ranking maps of specific condition variables were generated, and 3) the reach condition statistics were used to derive PCA system relative reach ranks.

Selecting Targets and Setting Goals: Both representation and connectivity goals were set; however, they were defined slightly differently than in the standard Aquatic Methods section. The representation goal was essentially the same: capture at least one example of each aquatic ecosystem type within each EDU. The connectivity goal was not based specifically on migratory species needs and on identifying connected examples of all types from headwaters to ocean. However, the CBY connectivity goals did suggest giving preference to selecting aquatic ecosystem types that maintained a high level of internal connectivity and connectivity to other aquatic ecosystems within the larger drainage network.

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[*] Perot, J. and A.P. Olivero, 2003. Results for aquatic systems. Chesapeake Bay Lowlands Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

[1] The text in this section is presented as a compilation of reports prepared by other colleagues and/or members of the planning team during the 1st iteration plan.

Portfolio Assembly: Instead of a TNC field office representative from each state serving at the final assembly meeting, Mark Bryer of TNC FWI represented VA and DE. Doug Samson represented MD. Mark Anderson and Arlene Olivero also participated and contributed to the assembly meeting. The codes assigned to portfolio examples varied in CBY from those documented in the Aquatics Methods section. First, CBY portfolio examples were coded into Tier 1 and Tier 2, which are analogous to S1 and S2 in the standard Methods section.[2] Second, portfolio examples were not coded "C" for being part of a connected focus network and were also not assigned a confidence code.

Classification Results

Ecological Drainage Units

EDUs were distinguished in the CBY ecoregion by two major factors, zoogeography[3] and physiography. Major physiographic distinctions primarily reflect the section levels assigned by the Forest Service.

Major freshwater zoogeographic regions that influenced EDU delineation were the Long Island Sound Subregion or WWF Atlantic Freshwater Ecoregion and Chesapeake Bay Subregion/Freshwater Ecoregion. As a result, the Delmarva Peninsula is divided into 2 EDUs: an Eastern EDU with streams draining into the Delaware Bay or Atlantic Ocean, and a Western EDU, with streams draining into the Chesapeake Bay. There are no major physiographic distinctions in the ecoregion according to the Forest Service. However, the western shore of Maryland and Virginia was broken into two EDUs to account for faunal differences in the Chesapeake Bay drainages. Drainages from just south of the Susquehanna to the Potomac drainage formed a Northern EDU. The Southern EDU is comprised of drainages from the Great Wicomico River south to the James River drainage.

Macrohabitats

Aquatic communities are best defined by analyzing biological data to identify assemblages of aquatic species. In most ecoregions, though, there are not sufficient biological data to characterize the diversity and distribution of aquatic communities at a scale appropriate for conservation planning in an ecoregion. Macrohabitats are units of streams and lakes that are relatively homogeneous with respect to size, and thermal, chemical, and hydrological regimes. Each macrohabitat type represents a different physical setting thought to contain distinct biological communities and is therefore a distinct conservation target.

Stream macrohabitats were mapped in a GIS across the Chesapeake Bay Lowlands using the three primary spatial data sets: hydrography, geology and elevation. Four stream variables were derived from these layers: stream size, connectivity (network position), gradient, and hydrologic and chemical regime. Lines representing stream reaches were attributed automatically by the

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[2] The standard methods for freshwater aquatic systems do not use the Tier 1 and Tier 2 code names to avoid confusion between the aquatic portfolio site codes and the terrestrial matrix Tier 1 and Tier 2 codes. The terrestrial matrix Tier 1 and Tier 2 examples have undergone a much more rigorous viability screening to determine that both Tier 1 and Tier 2 matrix forests are viable. The ecoregional planning team believed that viability screening of aquatic portfolio occurrences was not as well developed as terrestrial matrix screening, making the confidence in viability much lower for aquatic portfolio sites. Thus the "Tier 1" and "Tier 2" status have different meaning with respect to viability for the freshwater aquatic and terrestrial matrix portfolios in CBY.

[3] Maxwell et al. (1995) and the recently released WWF *Freshwater Ecoregions of North America* (Abell et al. 2000)

software and aggregated into macrohabitat types as unique combinations of the four classification attributes described below.

1. *Stream Size*

We defined five stream size classes based on link number, which is a count of the number of first order streams upstream of a point:

5.	Headwater	Link 1 – 10
6.	Creek	Link 11 – 100
7.	Small river	Link 101 – 1000
8.	Medium river	Link 1001 – 2500
9.	Large river	Link >2500

2. *Connectivity*

Stream connectivity describes the position in the drainage network, which was represented by the link number of the downstream reach. We used the same hydrography data layer and classes for stream connectivity as for stream size.

3. *Gradient*

In CBY we measured only one topographic factor, gradient, that is, the change in elevation of a stream reach over its length. Gradient is a useful single measure of channel morphology because it is correlated to sinuosity, pool-riffle pattern, confinement, substrate size, and water velocity. We calculated the gradient for each stream reach automatically from a digital elevation model (DEM), then averaged the gradient value for each macrohabitat. The four gradient classes used to classify the macrohabitats were:

1.	Very low gradient	<0.005
2.	Low gradient	0.005 – 0.02
3.	Moderate gradient	>0.02 – 0.04
4.	High gradient	>0.04

4. *Hydrologic and Chemical Regime*

We used the surficial and bedrock geology texture and stream size to infer the hydrologic regime and chemistry of each macrohabitat in terms of relative inputs of ground and surface water. The geologic codes in the Chesapeake Bay Lowlands and adjoining Piedmont ecoregion are:

Coastal Plain Surficial Geology Classes:

1	alluvial coarse
2	alluvial fine
3	alluvial/estuarine coarse
4	alluvial/estuarine fine
5	beach & dune
6	eolian sand
7	loam
8	marine fine
9	nearshore coarse
10	peat
11	saline marsh
12	silt/clay

Piedmont Bedrock Geology Classes:

100	acidic sed/metased
200	acidic shale
300	calcareous sed/metased
400	mod calcareous sed/metased
500	acidic granitic
600	mafic/intermediate granitic
700	ultramafic
900	coarse sed

Piedmont Surficial Geology Classes:

101	coarse-grained stratified sediment
102	fine-grained stratified sediment

The hydrologic regime and chemistry were classified for macrohabitats using the following rules:

a. Rules for 1st through 3rd order streams: If areal coverage of geology in watershed at and above the reach is >40 % stable (coastal classes: 1, 3, 5, 6 & 9 & bedrock classes: 300, 400, 900), then flow in the reach is stable, otherwise flow is unstable. If areal coverage of geology in watershed at and above reach is >40 % calcareous - neutral (coastal classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 & bedrock classes: 300, 400, 700), then chemistry is calcareous – neutral, otherwise acidic.

This resulted in four possible combinations for the hydrologic and chemical regime macrohabitat type:

5. Stable hydrology, calcareous - neutral chemistry (1, 3, 5, 6, 9 & 300, 400)
6. Unstable hydrology, calcareous - neutral chemistry (2, 4, 7, 8, 10, 12 & 700)
7. Stable hydrology, acidic chemistry (900)
8. Unstable hydrology, acidic chemistry (100, 200, 500, 600)

A fifth code was assigned to reaches at the Coastal Plain Saline Marsh (surficial geology class 11).

b. Rules for 4th and 5th order rivers: We assumed stable hydrology and calcareous-neutral chemistry unless:

For hydrologic regime, if areal extent of watershed at or above reach is >70% unstable (2, 4, 7, 8, 10, 12, 100 & 200) then flow in reach unstable, otherwise stable. For chemistry, if areal extent of watershed at or above reach is >70% acidic (100, 200, 500, 600, 900) then chemistry is acidic, otherwise neutral.

c. Rules for 6th order or larger rivers: We assumed stable hydrology and calcareous-neutral chemistry for all sixth order or larger rivers.

Aquatic Ecosystems

Where macrohabitats create a detailed and often quite complex picture of physical diversity, aquatic ecosystems are defined at a spatial scale to which experts relate well, and provide a means to generalize about the streams, lakes, and the ecological process that link groups of communities. Aquatic ecosystems are spatial assemblages of aquatic communities that 1) occur together in an aquatic landscape with similar geomorphological patterns; 2) are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains and other lateral environments) or environmental gradients (e.g., temperature, chemical and habitat volume); and 3) form a robust, cohesive and distinguishable spatial unit.

Within the Chesapeake Bay Lowlands ecoregion, there is considerable diversity in the types of macrohabitats. To describe this diversity, we looked for patterns in the macrohabitat types and four attributes used to classify them. Once patterns were observed, hydrologically-connected sets of segments were identified, described, and mapped across the ecoregion as aquatic ecosystems. These preliminary systems were reviewed and modified by experts (during the Viability Analysis process described below), and served as our coarse-filter aquatic targets for CBY.

Over 15,000 miles of nontidal streams and rivers were classified in the ecoregion, along with almost 2,400 miles of tidal waters (Map 3, Table aq7). Not surprisingly, almost half of the total mileage of mapped systems occurs in Virginia (39% nontidal, 6% tidal), with another 40% occurring in Maryland, and about one-sixth in Delaware. Tidal systems are equally abundant in Maryland and Virginia, while just under ten percent of the tidal total occurs in Delaware. About 30 miles of tidal and nontidal systems combined were mapped within the half of Washington, D.C. that falls within the CBY ecoregion.

The CBY ecoregion was initially classified into 12 aquatic system types in the four EDU’s (Map 3, Table aq1). A number of reaches located near the Fall Line in central and northeast Maryland, having geological and hydrological characteristics more typical of the Piedmont, were classified as System 11, but were subsequently excluded as being unrepresentative of the CBY ecoregion. In CBY, then, nine systems were classified as nontidal freshwater systems, and two (Systems 4 and 12) were tidal (Table aq1). One drainage in southern Maryland, Zekiah Swamp in Charles County (a tributary to the Potomac River) may represent its own unique system. However, there was insufficient data available to confidently classify it as a separate system, so it was included with System 1 in the present analysis.

Table aq1. Aquatic systems in the Chesapeake Bay Lowlands

System	Geology	Hydrology	Chemistry	Gradient	System Name	Characteristic Fish Species	Examples
1	Silt/clay, alluvial/estuarine fine & loam	Unstable	Neutral	Low, some very low or moderate	***Warmwater Headwaters*** in Northern Coastal Plain on Western Shore	Blacknose dace, creek chubsucker, eastern mudminnow, fallfish, least brook lamprey, pumpkinseed, rosyside dace	Tributaries to the Potomac, Patuxent & Parker, Plum Point, Fishing, Tracys, Muddy, North R., Bacon Ridge Br., Severn Run, Herring Run, Bird R. & Whitemarsh.
2	Loam	Stable	Neutral	Low	Nontidal, stable, neutral, ***cool-water headwater*** stream.	Brook trout, blacknose dace, mottled sculpin	Jabez Branch, Unnamed trib (?)
3	Acidic sed/metased & alluvial coarse	Stable	Acidic to neutral	Very low	Nontidal, stable, acidic to neutral, ***cool-water creek & small river*** size streams. Headwaters in Piedmont. Redwater system.	Banded killifish, brown bullhead, gizzard shad, quillback, shorthead redhorse, warmouth, yellow bullhead, yellow perch	Little Patuxent and Patuxent Rivers
4	Saline marsh	Tidal	Saline	Very low	***Tidal wetlands***		Aberdeen Proving Ground (Romney, Abbey, Mosquito, Back Cr.), Bombay Hook NWR, Little Creek WMA, Trap Cr. & Newport Cr., Cedar Is. WMA, Deer Is. WMA, Ches. Bay Nat Estuarine Research Reserve, Monie Bay, Blackwater R., Blackwater NWR, Fishing Bay WMA
5	Alluvial coarse, silt/clay, saline marsh, peat, eolian sand & marine fine.	Somewhat stable	Acidic	Very low	***Blackwater systems*** - acidic, brown-stained, poorly drained, very low gradient, vegetated headwater and some creek streams.	Banded sunfish, bluespotted sunfish, creek chubsucker, eastern mudminnow, pirate perch, redfin pickerel, tadpole madtom, yellow bullhead	Piankatank, Dragon Run, Buttons Cr. & Pocomoke R.
6	Loam	Somewhat stable	Neutral	Very low	Nontidal, poorly drained, neutral, headwater & creek size streams. ***Historically blackwater systems.***	American eel, bluespotted sunfish, creek chubsucker, eastern mudminnow, fallfish, golden shiner, pirate perch, pumpkinseed, redbreast sunfish, redfin pickerel, swallowtail darter, tadpole madtom	Headwaters and tributaries to the Choptank, Nanticoke and Wicomico Rivers.
7	Loam	Moderately stable	Neutral	Very low, some low	Nontidal, ***moderately stable***, neutral, headwater streams.	American eel, creek chubsucker, easterm mudminnow, fallfish, pirate perch, redbreast sunfish, redfin pickerel	Tributaries to the Elk, Bohemia, Sassafras, Chester & Wye Rivers.
8	Alluvial/estuarine coarse & nearshore coarse	Somewhat stable	Neutral	Very low	Nontidal, somewhat stable, neutral, very low gradient, headwater & creek sized streams ***on coarse material.***	Creek chubsucker, eastern mudminnow, golden shiner, pirate perch, red pickerel	Chicawcomico R., Transquaking R., Annemessex R., Manokin R., Back Cr., Muddy, & Underhill
9	Marine fine & loam	Unstable	Neutral	Very low	Nontidal, unstable, mostly short headwater & creek sized streams ***on fine material***.	No MBSS data	Christina, Appoquinimink, Blackbird, Smyrna, Jones, Leipsic, Murderkill, Mispillion, Cedar, Broadkill, Indian & St. Martin
10	Silt/clay, alluvial/estuarine fine & marine fine	Unstable	Neutral	very low	Nontidal, unstable, neutral, ***warm-water headwater*** & creek sized streams on Southern Coastal Plain		Tributaries to the Chicahominy, James, Mattaponi, Pamunkey & Rappahannock Rivers, and Brick Kiln, Poquoson, Ware, Great Wicomico.
11	Acidic granitic & acidic sedimentary/ metasedimentary	Unstable	Acidic	very low, low or moderate	Headwater & creek size, unstable, ***acidic streams in Piedmont***. Redwater system		Headwaters of Anacostia, Patuxent & Little Patuxent R., Hawlings & Middle Patuxent R., Grays Run, Swan & Gasheys Cr., Principio Cr., Stony Run, Northeast & Little Northeast Cr., Little Elk and Big Elk & Headwaters of Chicahominy R.
12	Loam & alluvial coarse	Tidal	Saline	very low	***Tidal rivers.***		Chester, Bohemia, Elk, Sassafras, Tuckahoe, Choptank, Marshyhope, Nanticoke, Pocomoke, Wicomico, Patuxent, Potomac, Mattaponi, Pamunkey, York, Rappahanock, Chicahominy, and James Rivers

Condition Results

After consideration of available data and expert resources in CBY, we followed a standard two-phase approach to assess the viability of aquatic ecosystem occurrences. First, we used available GIS data to perform a condition analysis and rank all watersheds (that encompass system occurrences) and individual stream segments according to landscape factors known to affect the biological integrity of aquatic communities. Second, we vetted the GIS analysis by holding workshops in Maryland, Delaware and Virginia to solicit expert opinion on the classification of aquatic systems in CBY, and on the location of best examples of high-quality, high diversity aquatic sites in the ecoregion.

GIS Condition Analysis

Condition analysis for watersheds and stream reaches is a subject of considerable ongoing research.[1] Inspired by these sources, we developed a set of attributes for watersheds and stream reaches that allowed us to evaluate watersheds and reaches in terms of variables related to freshwater aquatic condition. For both the watershed and reach level condition, we divided the available condition variables into three separate impact axes for analysis: 1) Land cover and road impact, 2) Dam impact, and 3) Point source impact. We felt it was unwise to try to combine the 3 separate axis ranks into a single summary rank because of disagreement over the relative importance of the 3 axes and the great variation a given watershed or reach could have in its rank for land/cover road impact vs. dam impact, vs point source impact. For the watersheds and reaches within a given system, we used PCA Ordination to develop a watershed and reach level rank in each of the three condition impact axes. We used GIS analysis and visual overlay of the top ranked watersheds and reaches to select 2 or 3 potentially high condition watersheds within each system type within an ecological drainage unit. Experts in each state were asked to review our GIS selected areas of potential high condition and delineate areas of best freshwater aquatic biodiversity significance per system type. The watershed ranks, stream reach ranks, ranking integration and site selection are described below.

Reach Level Statistics

Based on the directional flow coding of the RF3 GIS dataset, we summarized information on both the individual local watershed of a stream reach and its total contributing area upstream. For example, we calculated the % natural cover in the local watershed of a reach and also accumulated for the entire stream network above that given reach the % natural cover. We calculated over 40 condition variables for each reach related to landcover, roads, road stream crossings, various point sources, and element occurrences. These variables were divided into three categories for further analysis - 1) Land cover and road impacts, 2) Dam inpacts, and 3) Point Source impacts.

Reaches were then divided by system type and ranked for each of the three axes using PCA ordination. PCA ordination provided a means to integrate the individual variables within each axis area into a single continuous rank for reaches for a given impact axis. A subset of the most responsive and most different variables within each axis were chosen for inclusion in the PCA

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[1] See the excellent literature review by Fitzhugh (2001), Moyle and Randall (1998), and the TNC Freshwater Initiative Reach Level GIS Condition tools.

analysis. The subset of available variables that went into the PCA ordination are listed in Table aq2 below.[2]

Table aq2. Input variables for PCA ordination analysis.

Point Sources: (using superfund sites, PCS, IFD, TRI95)
PTS4NUM: number of point sources in local watershed of the reach
PTS4DEN: density of point sources (#/miles streams) in total upstream watershed of reach

Land Cover/Road:
RD_DENSITY: road density in upstream contributing area(miles/sq. mile)
RSC_DENSITY: road-stream crossings per stream mile in upstream contributing area
INDEV: percent developed within local watershed of reach
UPDEV: percent developed within total upstream watershed of reach
INAGR: percent agricultural within local watershed of reach
UPAGR: percent agricultural within total upstream watershed of reach
INNAT: percent natural within local watershed of reach
UPNAT: percent natural within total upstream watershed of reach

Dam:
DAMS : number of dams in local watershed of the reach
DAMSTORAGE: total dam normal storage in the local watershed of the reach
DAM_DENS: density of dams (#/miles streams) in total upstream watershed of reach
DAMST_DEN: total dam normal storage upstream/miles of streams upstream

After the ordination, the input variables for each reach were reduced into a single PCORD rank output value for each reach for that impact axis. These output values for a given axis were ranked from lowest to highest within each system and divided into 4 quartiles. The "top quartile by system" variable attributes were then coded for reaches to identify, within a given system, the reaches within the top quartile for land cover/roads, point sources, and/or dam impacts (Table aq3).

Table aq3. Output PCA ordination attributes.

dam#: pc ordination raw value on dam axis
lc#: pc ordination raw value on land cover/roads axis
pt#: pc ordination raw value on point source axis
rdam#: ranking of pc ordination value on dam axis within this system type
rlc#: ranking of pc ordination value on land cover/roads axis within this system type
rpt#: ranking of pc ordination value on point source axis within this system type
qdam#: given a 10 if this shed was in the top quartile for dams by system rank value
qlc#: given a 100 if this shed was in the top quartile for land cover/roads by system rank value
qpt#: given a 1 if this shed was in the top quartile for point sources by system rank value
qtopsum: sum of qdam#, qlc#, qpt#
    111 = top 10 in qlc#, qdam#, qpt#
    110 = top 10 in qlc#, qdam#
    101 = top 10 in qlc# and qpt#

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[2] The full reach level ranking analysis was only done for systems 10, 9,8,7,6,5, and 1. Systems 2,3,4, 11, and 12 were excluded from the ranking analysis because the system was too rare [systems 2 and 3 had only two occurrences each], because the system was tidal [system 4 and 12], or because the system occurred primarily outside the ecoregion and was not going to be considered in this ecoregion [system 11].

11 = top 10 in qdam# and qpt#
100 = top 10 in qlc#
10 = top 10 in qdam#
1 = top 10 in qpt#
0 = not top 10 in qlc#, qdam#, qpt# within its primary system type

Watershed Level Statistics

For the watershed level condition analysis, we used Maryland draft NRCS 14-Digit Watersheds and small occurrence watersheds delineated by Jen Perot in Delaware and Virginia. NRCS 14-digit watersheds for Delaware and Virginina were not used because they were incomplete and/or of a different scale than the Maryland watersheds. Eighteen variables related to landcover, roads, dams, and point sources were calculated for each watershed. A subset of the variables were selected for inclusion in a PCA ordination for each of the three impact axis – 1) Land cover/roads, 2) dams, 3) point sources. The variables used in the ordination are listed in Table aq4 below.

Table aq4. Input variables for PCA ordination analysis.

Land Cover/Road Impact:
Rdstdismi: average road to stream distance
P_dev: percent developed land cover
P_agr: percent agricultural land cover
P_nat: percent natural land cover
Rdstcmi: number of road stream crossings per stream mile
Rdmip1000a: miles of roads per 1000 acres of occurrence

Point Source Impact:
Cercpmi: number of superfund sites per stream mile
Ifwpmi: number of industrial facilities water discharge per stream mile
Pcspmi: number of pcs facilities water discharge per stream mile
Tripmi: number of tri water discharge (1995-2000 discharges only) per stream mile
Totptpmi: total point sources per stream mile

Dam / Hydrologic Alteration Impact:
Dwspmi: number of drinking water withdrawal locations per stream mile
Damspmi: number of dams per stream mile
Storpmi: average dam storage per stream mile
P414: percent channelized streams
Maxstor: maximum dam size in occurrence

After the ordination, the input variables for each watershed were reduced into a single PCORD rank value for that watershed for that impact axis. These output values were ranked from lowest to highest within the ecoregion. The watersheds were assigned to the primary system type that occurred within them. The “top10 by system” variable attributes was then coded to identify, within a given system, the watersheds with the top 10 ranks in each impact axis area (Table aq5). Note: sometimes more than 10 “top10” watersheds per system are identified due to ties in their PCORD values.

Table aq5. Output PCA ordination attributes.

Prifwisys: primary FWI system type in the occurrence/watershed
Perfwi: percent of streams that are of that primary FWI system type

Dam1: PCORD ordination axis 1 for Dam variables
Tox1: PCORD ordination axis 1 for Toxic variables
lc_1: PCORD ordination axis 1 for land cover and road variables
Damrank: dam ecoregional ranks from ordination
Toxrank: tox ecoregional ranks from ordination
Lc2rank: lc ecoregional ranks from ordination
Damind: individual within system ranks: 10 if the occurrence is in the top 10 for dams for its primary system type occurrences
Toxind: individual within system ranks: 10 if the occurrence is in the top 10 for point sources for its primary system type occurrences
Lc2ind: individual within system ranks: 10 if the occurrence is in the top 10 for land cover for its primary system type occurrences
Sumtop10: summary code for top 10 data within system type (combination of Damind, Toxind, Lc2ind)
    111 = top 10 in Damind, Toxind, Lc2ind
    110 = top 10 in Damind, Lc2ind
    101 = top 10 in Toxind, Lc2ind
    11 = top 10 in Damind, Toxind
    100 = top 10 in Lc2ind
    10 = top 10 in Damind
    1 = top 10 in Toxind
    0 = not top 10 in Damind, Toxind, Lc2ind within its primary system type

Selection of Potentially High Quality Watersheds from GIS condition analysis

Watersheds were displayed according to their within system ranks on the 3 impact axes (Map 14). The reachs were also mapping by their within system ranks to visualize whether the reach fell in all 3 axes top quartiles (best in land cover/roads, best in dams, best in point sources), 2 of the 3 axes top quartiles, 1 of the 3 axes top quartiles or none of the 3 axes quartiles (Map 14). We looked at the distribution of these “3,2,1, or 0 top quartile ranked reaches” in relation to our highly ranked watersheds (Map 14). This overlay was useful to distinguish/select between watersheds that came out in 1 or 2 of the Top 10 watershed axes areas because we could now investigate the distribution and abundance of the “best or good” quality individual reaches within the watershed. It was also useful to look at the distribution of the individual higher quality ranked reaches that occured outside of watersheds that came up in the Top 10 watershed analysis. These reaches may occur in a less desirable “watershed setting” but may still be of potential conservation interest, particularly if they represent macrohabitats that do not already occur in the “best” selected watersheds.

Before the expert meetings, we attempted to highlight potential areas of high aquatic biological significance based on the GIS analysis. By studying Map 14 and the underlying data, we were able to select 2 to 3 watersheds per system type and their reaches as areas of potentially highest freshwater condition. These 2 or 3 watersheds were selected primarily based on Arlene Olivero visually overlaying the summary “Top 10 watershed” information with the summary “Top quartile reaches” information for a given system. We found very few watersheds occurred in the “Top 10” in all three impact axes (best in land cover/roads, best in dams, and best in point sources), but when these watersheds occurred they were automatically selected as areas of potentially high freshwater aquatics condition. There was disagreement regarding the relative condition of watersheds that fell in 2 of the 3 “top 10 axes” or in just a 1 of the 3 “top 10 axes”. These “top 2 or top 1” watersheds were combined with further reach level statistics and other distinguishing information such as containing aquatic eos for further review. For Maryland, we selected 2 or 3 of the highest quality watersheds and their reaches for expert review based on overlay of Maryland IBI data and the raw condition statistics which were ranked across the entire ecoregion at the time. For Delaware and Virginia expert review meetings, rankings were run within system types, rather than across all system types.

Expert Workshops

Freshwater experts (Table aq6) in each state were presented with our Chesapeake Bay freshwater ecosystem classification and viability analysis in a series of workshops. During the workshops, the experts were asked to give their feedback on the classification, and make adjustments based upon their field knowledge of the aquatic ecosystems in the CBY. Once agreement on the classification was reached, we used it as a framework to structure discussions of where important areas of freshwater aquatic biodiversity existed, and especially ensure representativeness across the ecoregion. Using those areas selected in the GIS analysis described above as starting points, we asked the experts to confirm important areas based on their own experience. We used a standardized form to collect data associated with each nominated area (see below). These expert-delineated areas are shown in the portfolio as “expert-recommended areas of aquatic biodiversity significance.” This portion of viability assessment brought critical in-stream biological knowledge into the portfolio design.

Table aq6. List of freshwater experts interviewed during CBY process.

Name	State	Affiliation	Expertise
Paul Kazyak	MD	MD Dept. of National Resources	state-wide knowledge of IBI
Jim McCann	MD	MD Natural Heritage Program	Mussels
Nancy Roth	MD	Versar, Inc.	state-wide knowledge of IBI
Mark Southerland	MD	Versar, Inc.	state-wide knowledge of IBI
Rich Raesly	MD	Frostburg State University	Fish
Richard Orr	MD	U.S. D.A.	Odonates
Stephen McIninch	MD, VA	Virgnia Commonwealth University	Fish
Ellen Dickey	DE	DE Dept. of Natural Resources	Macroinvertebrates
Craig Shiry	DE	DE Dept. of Natural Resources	non-tidal fish
Greg Garman	VA	Virgnia Commonwealth University	Fish
Tony Silvia	VA	VA Dept. of Environmental Quality	water quality monitoring
Shelly Miller	VA	VA Dept. Game and Inland Fish	Fish

Data sheet used to collect information from freshwater experts.

The Nature Conservancy
Saving the Last Great Places

SPECIFIC INFORMATION ON RECOMMENDED AREAS OF AQUATIC BIOLOGICAL SIGNIFICANCE

Expert Name(s): ______________________________

Site Code: ______________________________

Site Name: ______________________________

Where is the site mapped? GIS paper map gazetteer

Site description (system type(s), unique or notable physical features, landscape setting, etc):

____

____

____

____

Biological significance (native assemblage, target species, any unique biological features, etc.)

____

____

____

____

Viability: Estimate the viability of the site: (rank either Very Good, Good, Fair, Poor)

CONDITION (biotic composition, local anthropogenic impacts, invasive species)	LANDSCAPE CONTEXT (altered flow regime, connectivity, watershed impacts)

Major stresses: Using the following list, circle up to 3 major stresses at this site:

A.

Habitat destruction or conversion

Habitat fragmentation

Habitat disturbance

Altered biological composition/structure

Nutrient loading

Sedimentation

Extraordinary predation/parasitism/disease

Modification of water levels; changes in flow

Thermal alteration

Groundwater depletion

Resource depletion

Extraordinary competition for resources

Toxins/contaminants

Other: ______________________________

Form (continued)**.**

Major sources of stress: Using the following list, circle up to 3 sources of stress at this site:

A. **Agricultural** (Incompatible crop production, livestock, or grazing practices)
B. **Forestry** (Incompatible forestry practices)
C. **Land Development** (Incompatible development)
D. **Water Management** (Dams, ditches, dikes, drainage or diversion systems, Channelization, Excessive groundwater withdrawal, Shoreline stabilization)
E. **Point Source Pollution** (Industrial discharge, Livestock feedlot, Incompatible wastewater treatment, Marina development, Landfill construction or operation)
F. **Resource Extraction** (Incompatible mining practices, Overfishing)
G. **Recreation** (Incompatible recreational use, Recreational vehicles)
H. **Land/Resource Management** (Incompatible management of/for certain species)
I. **Biological** (Parasites/pathogens, Invasive/alien species)
J. **Other:** ____

Urgency: How soon could the threats or existing situation at the site lead to destruction of the target elements that brought us there to begin with? Or, given the immediacy and severity of the threats, what is the urgency of protection at the site? Fit response into one of the following categories:

A. 1-2 years
B. 3-5 years
C. 6-10 years
D. 10+ years
E. Currently stable, but situation could change
F. Fully protected over the long term

Comments on viability (restoration required? Need additional data?):
____
____

Recommendations of Conservation Strategies (BMPs, dam removal, etc.):
____
____
____
____

Who is the lead contact person for additional information about this site?
Name ________________________________ Agency/Address____________________________________
Email ______________________ Phone ____

Given threats, probability of success, urgency and everything else discussed, should this site be included in the final suite of sites?

Yes - no regrets!
Provisional - Yes, given our current level of knowledge
No – Site is too threatened, conservation is not feasible here or the conservation targets present at this site are better represented elsewhere.

Portfolio Assembly

Conservation Goals

Our minimum goal was to capture examples of aquatic ecosystems across their ecological and geographic range. Since aquatic ecosystems tend to be large, and there are generally only a few occurrences of each type within each EDU, an initial goal was to conserve one example of each type within each EDU. In addition, we tried to select aquatic ecosystems that displayed a high level of internal connectivity and connectivity to other aquatic ecosystems within the larger drainage network.

The preferred approach to design a portfolio and priority conservation sites is to choose representative sites that conserve aquatic targets in tandem with terrestrial targets. At the Aquatic portfolio assembly meeting, the terrestrial portfolio had already been determined and was available for integration with the potential aquatic portfolio examples that had been verified by the experts.

Portfolio Occurrences

The portfolio of Aquatic Ecosystem occurrences in the CBY ecoregion consists of 51 sites (i.e., local networks of contiguous aquatic communities) identified through an expert-opinion process, including 46 in nontidal freshwater systems, and 5 in tidal systems (Map 3, Table aq7 and aq8). The expert-recommended nontidal occurrences totaled almost 1900 miles, or about 13% of the total mileage of the mapped systems, with another 441 miles of tidal system 12 (but not system 4) also recommended by experts (combined total remains about 13% of all mapped systems).

During the workshops used to select high-quality aquatic ecosystems in CBY, the experts were asked to identify at least one occurrence in each system type in their state, if possible. But the size (i.e., mileage of contiguous segments included) of recommended occurrences was not defined, and the total number of recommended occurrences was not limited, within or among states. Thus, among 10 system types, the final number of expert-selected occurrences in the portfolio varied from 1 to 14 (average of 5), and the average mileage of an occurrence per system type varied from 2 (System 2) to 109 (System 10), with an overall average of 41 miles (not shown in Table aq7).

The proportion of the total mileage of each system type in the ecoregion recommended for the portfolio varied considerably, then, as a function of both the number and size of occurrences recommended, and the total system length in CBY. For the three least common system types (2, 3, and 5), a third or more of the entire system mileage of each was recommended for the portfolio, because the number and/or size of the occurrences identified as high-quality were a significant proportion of the ecoregional total (Table aq7). Similarly, a third of tidal System 12 was expert-recommended, but here multiple occurrences of greater-than-average length compensated for the fact that there are over 1300 miles of this system type in the ecoregion.

Table aq7. Mileage and proportions of aquatic system types, expert-recommended occurrences (all and Tier 1 only) by system type, and state totals, in CBY.

SYSTEM	EDUs	Total in ecoregion		All Expert-Recommended Occurrences				Tier 1 Expert-Recommended Occurrences			
		Miles[1]	%[2] of All Systems	Total Number	Miles[2]	% of System	% of ER Only[3]	Total Number	Miles	% of System	% of ER[4]
Nontidal Freshwater Systems[5]											
1	3,(4)	3323	19	5	234	7	10	3	194	6	9
2	3	6	0	1	2	33	<1	1	2	33	<1
3	3	110	1	2	51	46	2	0	0	0	0
5	(1),2,4	739	4	3	254	34	11	3	254	34	12
6	1,2	2008	12	9	412	21	18	7	381	19	18
7	1,(2)	829	5	3	135	16	6	2	114	14	5
8	1,2,(3)	1320	8	4	27	2	1	0	0	0	0
9	1,2	1720	10	14	219	13	9	7	168	10	8
10	(3),4	4962	29	5	544	11	23	5	544	11	26
CBY, All Nontidal		15018	86	46	1878	13	81	28	1657	11	79
Tidal Systems[6]											
4	1,2,3	1028	6	NA	NA	NA	NA	NA	NA	NA	NA
12	(1),2,3,4	1333	8	5	441	33	19	5	441	33	21
DC, All Systems		30	0	0[7]	0	0	0	0	0		
DE, All Systems		2662	15	14	531	20	23	13	519	19	25
MD, All Systems		6833	39	18	730	11	31	11	589	9	28
VA, All Systems		7853	45	19	1057	13	46	9	990	13	47
CBY, All Systems		17378	100	51	2319	3	100	33	2098	12	100

[1] Reach mileage for wide and/or tidal rivers (i.e., with 2 shorelines in GIS) was adjusted appropriately

[2] All mileage numbers and proportions rounded to whole numbers

[3] Across all systems (i.e., proportion of 2319 miles)

[4] Across all Tier 1 systems (i.e., proportion of 2098 miles)

[5] System 11 occurs largely outside of CBY

[6] Experts did not recommend occurrences for system type 4

[7] No expert workshop was held to select occurrences in DC

Two other systems, on the other hand, had very low percentages of their total lengths included in the portfolio. Warmwater headwaters on Maryland's western shore (System 1) had five occurrences of average size (47 miles) recommended by the experts as high-quality, but that system is the second-most common in CBY. Headwater and creek-sized streams on coarse material (System 8), which had a total length that was more or less average among CBY systems, had four occurrences recommended, but they were quite small (only 7 miles each, on average). Finally, the numbers and sizes of occurrences recommended by experts for the remaining four systems, relative to total system length, were such that between 11 and 21% of each was included in the portfolio (Table aq7).

Conceptually, the planning team could have set a goal of including at least, say, 10 or 20% of the total length of each aquatic system type in CBY in the portfolio to ensure the conservation of rare and common aquatic species and natural communities in the ecoregion. Numerous technical, theoretical and logistical constraints, however, made this approach unfeasible. Thus, among expert-recommended portfolio sites, some systems are considerably (System 8) to somewhat (Systems 1, 10) underrepresented, while several others are notably (i.e., Systems 3, 5, 12) to somewhat (System 6) overrepresented, relative to their proportional composition in the ecoregion as a whole (Table aq7).

Note that, although a larger proportion of all mapped reaches were expert-recommended as portfolio occurrences in Delaware (20%) than in Maryland (11%) or Virginia (13%), the proportional representation in the overall portfolio is higher in Maryland (31%) than in Delaware (23%), and much higher in Virginia (46%), because the mapped total mileage was much higher in the latter two states (Table aq7).

The 51 portfolio occurrences were divided into Tier 1 (33) and Tier 2 (18) sites (Map 3, Table aq8). Tier 1 are those that were identified by experts as the highest-quality occurrences in each system type, judgements that were further supported by the watershed condition analyis (above and Map 14). Tier 2 sites were also identified as good aquatic ecosystem occurrences, but there was less data and information available to support the higher ranking for this group. Although only about 65% of the total number of all expert-recommended occurrences (tidal and nontidal) were designated as Tier 1 sites, several systems (2, 5, 10, 12) had all of their occurrences ranked as Tier 1, and several others had from 77 to 92% of their occurrence mileage ranked as Tier 1. Although two systems (3 and 8) had no selected occurrences designated as Tier 1, their total mileage of expert-recommended occurrences was quite low to begin with. So across all systems (tidal & nontidal), 90% of the total mileage of expert-recommended occurrences occurred at Tier 1 sites (Table aq7). Because so much of the total mileage of all expert-recommended sites combined was ranked as Tier 1, the proportional representation of the different system types among all Tier 1 occurrences was essentially the same as the pattern among systems for all expert-recommended sites (above, and Table aq7).

In CBY, there was greater representation of some aquatic system types than others within matrix forest blocks, because blocks did not fall randomly across the ecoregion. Matrix forest blocks as a group encompass about 12% of the land area of the ecoregion, and so the overall proportional occurrence of aquatic system mileage within all blocks (12%) should and does match that figure (Table aq9). But among systems, several types were over-represented proportional to their mileage in the ecoregion, while others were underrepresented. For example, cool-water headwater streams (System 2) and cool-water creek & small river-sized streams (System 3) had more than 20% of their total mileage occur within matrix forest blocks (Table aq9). This result is perhaps not too surprising, given that these are the two rarest system types in the ecoregion; any capture by a matrix block would likely represent a large proportion of their total mileage. Similarly, more than half of the total mileage of blackwater streams (System 5) in the ecoregion fell within one or more matrix blocks. The third least common system in CBY, blackwater streams occur in the Dragon Run watershed in Virgina - almost all of which fell inside of the Dragon Run matrix forest block - and in the Pocomoke River watershed in Maryland, a large portion of which fell within the Nassawango-Dividing Creek matrix block (Map 15).

Table aq8. Expert-recommended aquatic ecosystems occurrences (Tier 1 and Tier 2) in CBY. See Map 15 for locations.

Site Map Label id	State Interview Sheet id	Site Name	Tier	Primary System	Total Milage	States	EDU	Matrix Name	Miles in Matrix	% in Matrix
1	MD_13_1	Zekiah Swamp	1	1	149	MD	3	Zekiah	70	47
2	MD_1_1	Nanjemoy Creek	1	1	27	MD	3	Nanjemoy	27	100
3	MD_1_4	Jarbonesville Run/Upper St. Mary's	1	1	18	MD	3	St. Marys	13	73
4	MD_1_3	Lyons Creek	2	1	26	MD	3			0
5	MD_1_2	Patuxent River, West Branch	2	1	14	MD	3			0
6	MD_12_1	Little Patuxent, Trib	1	2	2	MD	3	Patuxent WRC	1	91
7	MD_3_2	Patuxent River	2	3	26	MD	3			0
8	MD_3_1	Little Patuxent River	2	3	24	MD	3	Patuxent WRC	11	45
9	MD_5_1	Nassawango Creek	1	5	55	MD	2	Nassawango	44	80
10	MD_5_2	Dividing Creek	1	5	46	MD	2	Nassawango	42	92
11	VA_3	Dragon Run/Piankatank River	1	5	157	VA	4	Dragon Run	153	98
12	DEH_1	Deep Creek	1	6	77	DE	2	Redden - Ellendale	31	40
13	DE_6_2	Gravelly Branch	1	6	65	DE	2	Redden - Ellendale	49	75
14	DE_6_5	Cow Marsh Branch	1	6	4	DE	2			0
15	DE_6_4	James Branch	1	6	88	DE, (MD)	2			0
16	MD_6_5	Upper Choptank/Gravelly Branch	1	6	40	DE, (MD)	2			0
17	MD_6_4	Tuckahoe River	1	6	10	MD	2			0
18	MD_6_1	Marshy Hope Creek	1	6	60	MD, (DE)	2			0
19	MD_6_2	Wicomico River	2	6	16	MD	2			0
20	MD_6_3	Tonytank Creek	2	6	15	MD	2	Nassawango	2	15
21	DE_7_1	Chester Headwaters	1	7	91	DE, (MD)	2	Black Bird Creek / Millington	29	31
22	MD_7_1	Red Lion Branch, Chester River	1	7	25	MD	2			0
23	MD_7_2	Browns Branch, Chester River	2	7	21	MD	2			0
24	VA_19	Underhill Creek/Taylor Creek	2	8	13	VA	2			0
25	VA_10	Sandy Bottom Branch	2	8	6	VA	2			0
26	VA_14	Holt Creek	2	8	4	VA	2			0
27	VA_13	Greens Creek	2	8	4	VA	1			0
28	DE_9_1	Broadkill River	1	9	44	DE	1	Redden - Ellendale	26	59
29	DEH_5	Cow Bridge Branch	1	9	40	DE	1			0
30	DEH_3	Mudstone Branch	1	9	27	DE	1			0
31	DE_9_3	Blackbird Creek	1	9	24	DE	1	Black Bird Creek / Millington	23	96
32	DEH_2	Brown's Branch	1	9	19	DE	1			0
33	DEH_4	Johnson Branch	1	9	9	DE	1			0
34	DEH_6	Chapel Branch	1	9	5	DE	1			0
35	DE_9_2	Black Swamp Branch - Murderkill Trib.	2	9	10	DE	1			0
36	VA_18	Nassawadox Creek	2	9	12	VA	2			0
37	VA_11	Garathy Creek	2	9	8	VA	1			0
38	VA_16	Hungars Creek	2	9	7	VA	2			0
39	VA_15	The Bulf, Eastville	2	9	7	VA	2			0
40	VA_12	Ross Branch	2	9	4	VA	1			0
41	VA_17	Warehouse Creek	2	9	2	VA	2			0
42	VA_8	Fort A.P. Hill Rappahannock River tributaries	1	10	123	VA	4	A.P. Hill, Upper Rappahannock	112	91
43	VA_1	Cat Point Creek	1	10	117	VA	4	Upper Rappahannock	25	22
44	VA_2	Lower Chickahominy River tributaries	1	10	113	VA	4			0
45	VA_7	Doctor's Creek/Marracossic Creek	1	10	111	VA	4	A. P. Hill	23	21
46	VA_9	Pole Cat Creek	1	10	78	VA	4			0
47	MD_12_2	Choptank Mainstem	1	12	100	MD	2			0
48	VA_6	Mainstem Mattaponi River	1	12	110	VA	4	Dragon Run	25	23
49	VA_20	Pamunkey River	1	12	95	VA	4			0
50	VA_5	Mainstem James R. (tidal freshwater zone)	1	12	87	VA	4			0
51	DE_6_3	Nanticoke River	1	12, 6	86	MD, (DE)	2	Nanticoke	37	43

Table aq9. Aquatic ecosystems in matrix forest blocks, expert-recommended occurrences, and expert-recommended occurrences within matrix blocks in CBY.

		In Matrix Blocks		Expert-Recommended		Expert-Recommended in Matrix Blocks		
System[1]	**Total in CBY**	**Miles[2]**	**% of Total[2]**	**Miles**	**% of Total[3]**	**Miles**	**% of ER Total[3]**	**% of Matrix Total[3]**
1	3323	326	10	234	7	110	47	34
2	6	2	33	2	27	2	100	100
3	110	27	25	51	46	11	22	41
4	1028	165	16	NA	NA	NA	NA	NA
5	739	391	53	254	34	238	94	61
6	2008	189	9	412	23	91	22	48
7	829	61	7	135	17	29	21	48
8	1320	24	2	27	2	0	0	0
9	1720	88	5	219	13	49	22	56
10	4962	599	12	544	11	161	30	27
12	1333	145	11	441	33	56	13	39
Total	17378	2017	12	2319	14	747	32	37[4]

[1] Experts did not recommend sites for System 4 and System 11 occurs largely outside of CBY.

[2] All mileage numbers and proportions rounded to whole numbers.

[3] Within the system

[4] System 4 mileage excluded from matrix total

Several system types, on the other hand, were notably underrepresented within matrix blocks. Systems 7, 8 and 9 each had less than 10% of their total mileage represented within a matrix forest block (Table aq9). These systems, though, are the most common types in the central and north-central Delmarva Peninsula (in both MD and DE), a landscape dominated by agriculture and small-town development, and lacking the large forested tracts necessary for matrix forest blocks (Map 15).

Note that Systems 10, 1, and 6, which had the greatest total mileage occurring within matrix forest blocks (ignoring System 5), were the three most common types in CBY (Table aq9). The total mileage of these systems that fell within matrix forest blocks, though, was proportional, more or less, to their overall occurrence in the ecoregion. This result was also true for tidal system 12 (Table aq9).

There was also a strong relationship between expert-recommended occurrences and matrix forest blocks. As discussed above, experts selected about 13% of the total mileage of aquatic systems (tidal and nontidal) in CBY on average, with as little as 2% of some systems and as much as 46% of other systems recommended as highest-quality occurrences (above, and Table aq9). But almost one-third of all expert-recommended reaches occurred within a matrix forest block, and several systems (1, 2, and 5) had significant proportions of their expert-recommended occurrences fall within a block (Table aq9). Similarly, although experts recommended only 13% and 11%, respectively, of Systems 9 and 10 for inclusion in the portfolio, 22% and 30% of those system miles, respectively, fell within a matrix forest block (Table aq9).

On the other hand, cool-water creek & small river streams with headwaters in the Piedmont (System 3) and tidal rivers (System 12), were well-represented proportionally among all expert-recommended occurrences, but fell less commonly within matrix forest blocks than the overall average, as would be expected. Two other types, historically blackwater streams (System 6) and moderately stable headwater streams on the Delmarva Peninsula (System 7), occurred in matrix blocks roughly in proportion to their representation among all expert-recommended sites. Only a single system type, headwater and creek-sized streams on coarse material (System 8), had no expert-recommended mileage that fell within a block. As noted above, this system characterizes a landscape that lacks large tracts of intact forest.

Finally, about a third of expert-recommended occurrences ecoregion-wide fell within matrix forest blocks, and 37% of all stream reaches within matrix blocks were expert-recommended (Table aq9). While these similar results might seem to be expected intuitively, the latter statistic is the complex result of: 1) systems that are over-represented (compared to the average) in matrix forest blocks, and which had a large proportion of their total mileage in blocks recommended by experts (i.e., Systems 2, 5); 2) systems under-represented in matrix blocks, but where they did occur, they were recommended by experts (i.e., Systems 7 and 9); 3) systems that were represented in matrix blocks more or less proportionally to their abundance in the ecoregion, but segments of which were recommended by experts within matrix blocks at a higher frequency than outside of matrix blocks (e.g., systems 1, 10, and 12). Put more simply, the sizes of expert-recommended occurrences relative to the total mileage of streams falling within matrix blocks, combined with a strong tendency for recommending occurrences within blocks, means that the abundance of portfolio occurrences within matrix forest blocks (37%) is almost three times higher than the overall abundance (13%) of expert-recommended sites in the ecoregion (Table aq9).

Information Gaps and Strategies for Improvement

Identifying the suite of priority aquatic conservation sites that will represent an ecoregion's aquatic biodiversity requires a comprehensive picture of aquatic ecosystem and biological diversity. However, many ecoregions, including CBY, have limited or currently unavailable spatially-referenced information about the distribution of aquatic species, and generally lack data on natural aquatic assemblages. The use of GIS based macrohabitats, aquatic ecosystems, and expert review to build portfolios will provide conservation planners with significant information regarding patterns of community-level diversity in aquatic ecosystems. But sites based on physically-defined targets should be considered provisional until the biological significance can be verified. The level of confidence in a portfolio developed using the macrohabitat and/or system approach can be improved by consulting with regional and local experts to further determine biological content and significance, conducting field investigation to verify high quality macrohabitat and/or community occurrences, and carrying out biological inventory and analysis to build the biological community classification.