Stream Mitigation Requirements and the 401 Water Quality Certification and Isolated Wetland Programs: Proposed changes in internal DWQ policy

NC Division of Water Quality
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Executive Summary

The Division of Water Quality's 401 Water Quality Certification and Isolated Wetland rules require stream mitigation to replace unavoidably impacted streams (15A NCAC 2H .0506(b)(6) and 2H.1305 (c)(6), respectively). The 401 Certification rules do not specify stream mitigation ratios while the Isolated Wetland rules specify a 2:1 stream ratio if impacts exceed 150 linear feet. For the 401 rules, the general water quality standard of protection of aquatic life use (15A NCAC 2B .0211(1)) also applies. Therefore, the 401 rules require replacement of the aquatic life use of a stream when impacts are unavoidable. Presently, DWQ only requires mitigation for perennial stream impact. Mitigation for intermittent streams has not been required since it has not been clear to what extent intermittent streams have aquatic life uses. However based on a five-year effort to monitor aquatic life uses across the state (summarized in this report), it is now clear that intermittent streams do support aquatic life uses in N.C. Therefore, the Division proposes to modify our compensatory mitigation policy, after appropriate public notice and comment, to require compensatory mitigation for the unavoidable loss of intermittent streams. In addition, the net statewide stream impact (impacted stream length minus mitigated stream length) has been negative in N.C. for many years. This fact also supports the need for DWQ to require additional stream mitigation when appropriate.

Proposed policy

It is proposed that intermittent streams be mitigated for at the same rate (1:1) as currently required for perennial streams for the 401 Certification Program. As noted below, mitigation to isolated streams (streams that go underground for more than a few feet before resurfacing) is required at a 2:1 ratio and this policy will not change that rule (15A NCAC 2H .1305 (c) (6)).Mitigation will continue not to be required for projects with impacts to less than 150 feet of intermittent and perennial streams. In addition, DWQ will accept mitigation sites that involve intermittent streams as adequate intermittent stream mitigation as along as the required mitigation ratios are met. However, we do not intend to require restoration of intermittent streams to compensate for intermittent streams impacts. Our goal is to replace the aquatic life use lost through intermittent stream impacts and restoration of perennial streams provides replacement of that use.

Aquatic life value of intermittent streams in North Carolina

Water quality value of intermittent streams

Intermittent streams are defined as streams that, during a year of normal rainfall, have water in them for several months, but also are dry for some period of time[1]. In forested catchments, the intermittent segment of a stream is usually relatively short (less than 100 feet). However in developed watersheds and regions where rapid runoff occurs (e.g. the Triassic Basin and Eastern Slate Belt), intermittent segments can be

[1] Definitions of ephemeral, intermittent and perennial streams are those used in 15A NCAC 2B.0233(2).

longer. Headwater streams (1st and 2nd order, intermittent and perennial) drain 55-85% of a watershed (Gregory, in USFWS 2000) so they are very important conveyances of water and chemical constituents (nutrients and sediment). The small size of the stream ensures a large amount of water-sediment contact, which removes nitrogen from runoff via nitrification and denitrification by bacteria in the sediments (Mulholland et al 2001, Peterson et al 2001). This increased contact also allows a higher rate of adsorption of

phosphorus to soil particles in the headwater stream bed than in larger streams (James Gregory, personal comm.). Sweeny (USFWS 2000) has calculated that if the nutrient reduction functions of these headwater streams were removed (e.g. by culverting the stream), it would be nearly impossible to successfully implement a nutrient reduction strategy in a watershed. Wallace (USFWS 2000) has also found that these headwater streams are a major source of organic carbon (food) to aquatic ecosystems. Up to half of the organic carbon flowing through aquatic ecosystems originates as leaf litter in headwater streams that has been broken down and converted to more usable forms of carbon by the bacteria, fungi and invertebrates in these headwater streams.

Monitoring Methods

Biological sampling of benthic macroinvertebrates occurred three times per year in the ephemeral, intermittent and perennial stream reaches in each of 15 study catchments across the state (Figure 1). Sampling times were selected to capture seasonal differences as well as varying flow conditions: (1) May - when base flow is decreasing due to increased evapotranspiration, (2) September – when base flow is at the seasonal low in perennial streams and has stopped in intermittent streams, and (3) late February – when base flow is near the seasonal high in both intermittent and perennial streams.

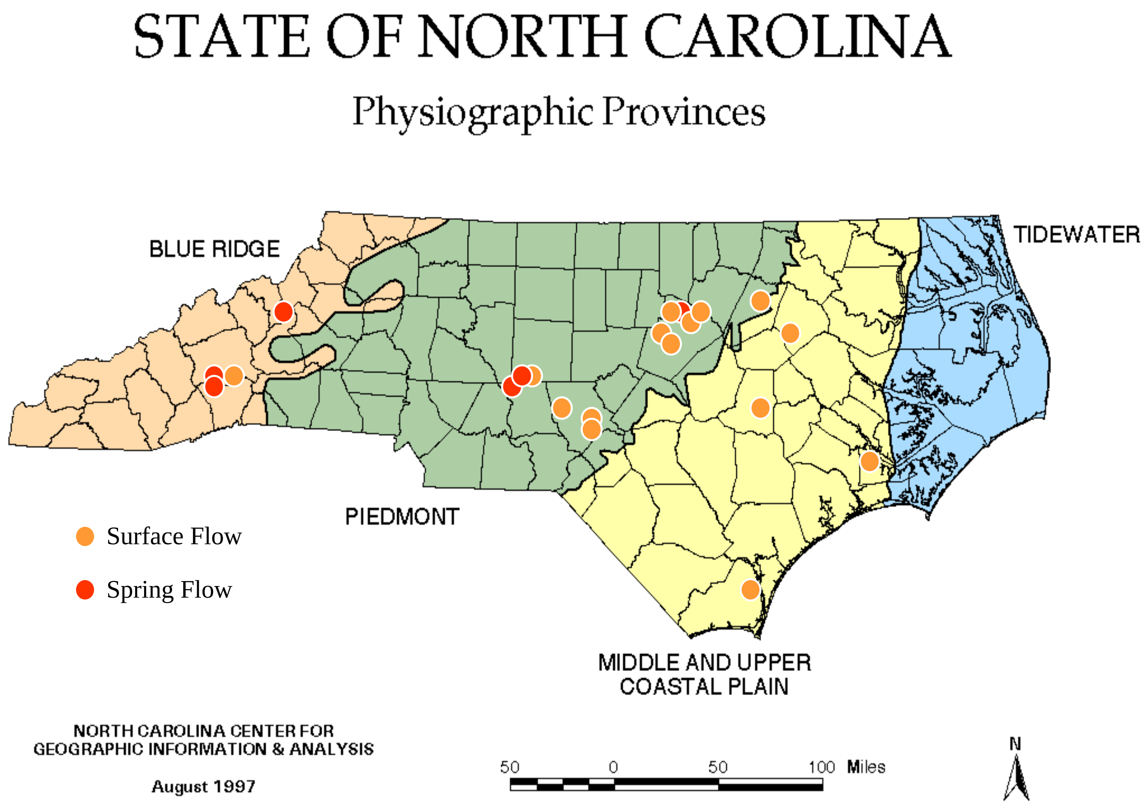
Different macroinvertebrate sampling methods were employed depending on the presence or absence of water in the stream reach being sampled. Irrespective of water level, an area of 200 cm^2 of the stream bed was collected to a depth of 10 cm. This method was dubbed the Box Core or the Quantitative method. The invertebrate community was separated from the sediment by elutriation through a 300 micron mesh screen in the field and the sediment was returned to the streambed. Macroinvertebrates were returned to the laboratory for sorting enumeration and identification.

Wet sampling (i.e., when there was water in the channel) consisted of two samples in addition to the box core described above, and were kept separately from that quantitative sample. Two sweeps were taken with a dip net - one in a pool, one in a riffle, if the features existed. Additionally 10 rocks were washed down and sieved through a 300 micron mesh net to collect attached invertebrates. These samples were returned to the laboratory in 70% ethanol, where sorting and identification took place.

Aquatic life and intermittent streams in the Piedmont

In 2001, DWQ received a grant from the EPA to document the aquatic life inhabiting intermittent streams. Initially, eight headwater streams in Wake County parks were monitored for flow permanence and the presence or absence of aquatic life. Ephemeral, intermittent and perennial stream segments were identified using DWQ's stream identification form. A stratified random sampling design was used to select four sites to be sampled in each stream: one in an ephemeral (stormwater-driven) reach, one in an intermittent, and two in the perennial, usually one close to the perennial origin and one further down stream.

Figure 1. Map of Study Sites



In the summer of 2002, when sampling started, the State was experiencing the height of the worst drought in over 50 years (10/2001-9/2002 9.3 inches below normal at RDU airport). Perennial streams, which citizens had not seen go dry in 20 years, were without water. The drought broke that fall and 2003 was a much wetter than normal year (+16.9 inches), which recharged the groundwater significantly. Consequently, the perennial and intermittent segments stayed wet all year. Finally, 2004 was a year of slightly above normal rainfall (+3.9 inches) and most perennial streams contained water all year while most intermittent segments were dry again.

Figure 2 shows how stream headwaters respond to changes in groundwater level due to drought. With 2004 as a baseline, during drought (2002), the groundwater levels fall and the origin of the stream moves downslope – intermittent segments become ephemeral and barely perennial segments become intermittent. During wet years (2003), groundwater levels recharge to the point where the stream origin moves upslope of the baseline – lower ephemeral sites become intermittent and intermittent sections become perennial.

Figure 2. Seasonal Aquatic Abundance in Ephemeral, Intermittent and Perennial stream segments.

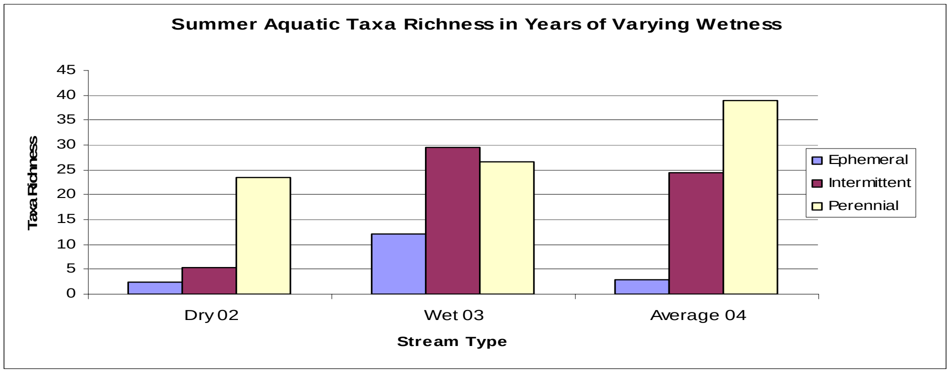
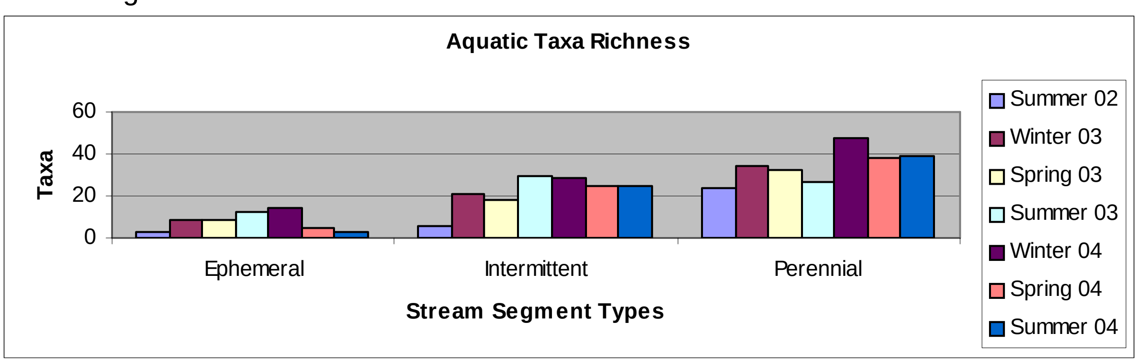


Figure 3 shows the Average Taxa Richness (respectively) for Ephemeral, Intermittent and Perennial stream segments for summer, winter and spring 2002-2004. This graph demonstrates that intermittent segments support significant levels of aquatic life, even when the stream is dry (summer of 2002 and summer 2004). In nearly all cases, intermittent stream segments in the Piedmont have more aquatic life and a greater number of aquatic species than ephemeral reaches, but less than perennial segments. Recovery from the 2002 drought can be seen in all reaches through spring 2003. However, recovery was less in perennial segments (30-50% increase) than in ephemeral and intermittent reaches (more than 500% increase) where drying was more severe. Seasonal patterns (recruitment in winter and spring, and stress-related depressions in taxa richness and abundance in summer) were more obvious in perennial reaches than intermittent and ephemeral segments. Periodic drying seems to be a larger stressor than seasonal changes in these upstream segments. It appears to take nearly two years for the abundance of aquatic organisms in a segment that has dried to return to levels comparable to segments that never dried. In addition, reduced habitat in intermittent segments appears to limit the number of different species relative to perennial segments. Over the course of this study, ephemeral segments averaged 6.4 aquatic species and 70 aquatic individuals per site, intermittent segments had an average of 22 species and 181.9 individuals per site and perennial sites averaged 32.9 species and 313.8 individuals per site for each evaluation. Intermittent stream segments in the Piedmont have more than half (58%) of the aquatic abundance and two thirds (67%) of the aquatic diversity of small perennial streams.

Figure 3. Seasonal Aquatic Taxa Richness in Ephemeral, Intermittent and Perennial stream segments.



Most taxa in ephemeral reaches are terrestrial: ants, spiders, millipedes, earthworms and terrestrial fly larvae. The few aquatic taxa present are mostly small, elongate, diptera (fly) larvae that survive in the damp spaces between the sand grains in the streambed. Intermittent stream segments have a much more even mix of terrestrial and aquatic species, with the composition shifting as the water table rises above the stream bed or falls below it. When the water table is above the elevation of the stream bed, the stream is wet and short-lived aquatic species, such as amphipods, isopods, winter stoneflies, diving beetles, and various dipteran (fly) larvae, dominate the community. Most of these aquatic organisms are also found downstream in the perennial reaches since only a few species (e.g. the diperan *Dasyhela* and the larvae of the aquatic beetle *Helichus*) live only in the intermittent segments. These observations are similar to those of Boulton and Lake (1992); del Rosario and Resh (2000); and Feminella (1996) who found that rather than being discrete communities, biota in ephemeral, intermittent and perennial segments mostly are distributed along a gradient – the more tolerant or drought resistant the species, the further up the Ephemeral /Intermittent/Perennial (E/I/P) continuum it can be found. This community continuum shifts up and down the stream depending on the season and the wetness or dryness of the year. Terrestrial species, as listed above, dominate the community when the water table falls below the surface of the streambed and the intermittent segment dries up. Species living downstream in perennial reaches include nearly all of the species found in intermittent segments, plus a suite of species that require water year around to complete their life cycles. These groups include mayflies, stoneflies (non-winter), caddisflies, dobsonflies, dragonflies, damselflies, some beetles (riffle beetles and water pennies), most mollusks, larval salamanders and fish. This group of organisms has been used to refine DWQ's definition of perennial streams.

Aquatic life and intermittent streams in the mountains

Intermittent streams are the exception, rather than the rule in undeveloped catchments in the mountains. Most streams in the mountains, as well as some in the piedmont, start as perennial springs. Some, usually short, intermittent segments do exist, and are formed from two very different sources: wet weather springs and overland runoff from development.

Two wet weather springs were located and monitored for one year in the mountains. Data from the spring off the Blue Ridge Parkway, in McDowell County, is typical. Figures 4 and 5 are the taxa richness and abundance (respectively) at an intermittent segment and two perennial segments. The trend with wet weather springs is similar to that of piedmont intermittent systems that are more surface water-driven. When the segment is dry, there is little aquatic life in the segment (mostly dipteran taxa between the sand grains). When water is flowing in the reach, the abundance of aquatic life is comparable to down-stream perennial reaches, even if the diversity is about half of that in perennial streams.

Two streams arising from overland flow were sampled, one near Asheville, in Buncombe county, and one in the Uwharrie mountains in Montgomery county. Data from these sites (Figures 6 and 7) show a similar pattern, but with more aquatic life, as compared to the Wake County (piedmont) streams (Figures 2 and 3). As in Piedmont streams, there was little aquatic life in ephemeral segments, with increasing numbers of species and individuals as the stream develops throughout the short intermittent reaches to the perennial. The main difference between Mountain and Piedmont is how quickly the streams become perennial, and how much aquatic life these streams support. In the Piedmont perennial streams, aquatic life included 190-450 aquatic organisms from 22-45 species. In Mountain streams, perennial streams supported 200-1200 aquatic organisms from 22-70 species.

Figure 4. Taxa richness at sites off the Blue Ridge Parkway.

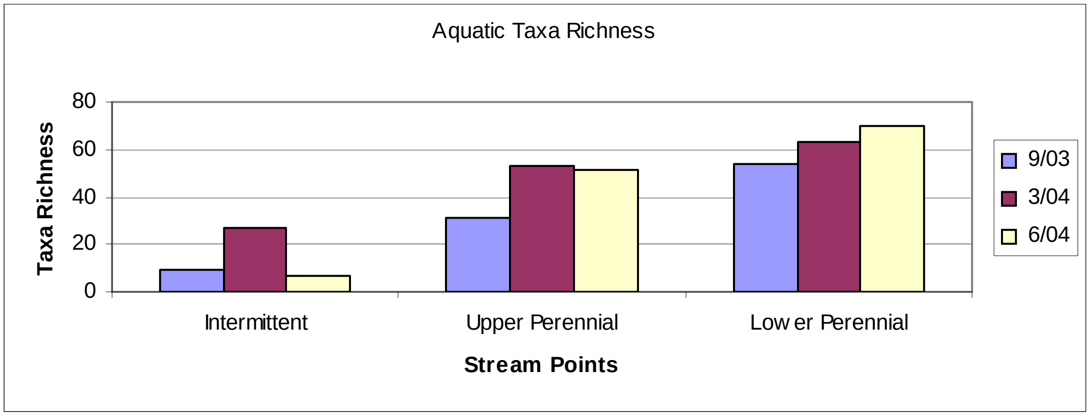


Figure 5. Aquatic abundance at sites off the Blue Ridge Parkway.

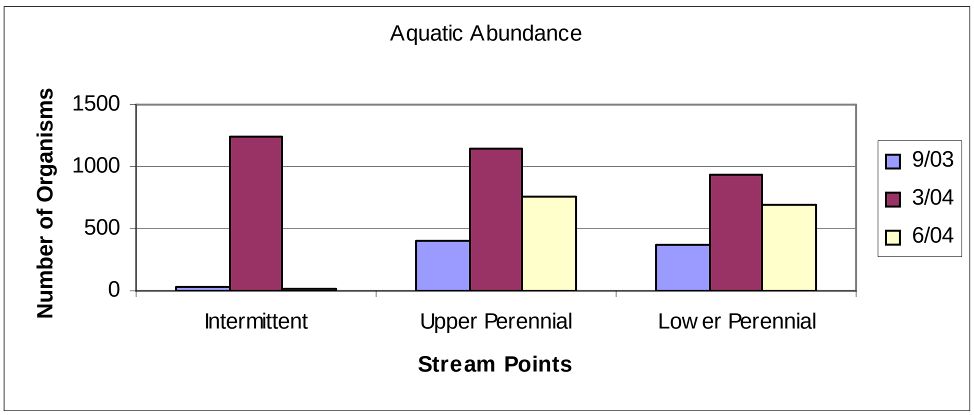


Figure 6. Taxa Richness of Mountain Streams.

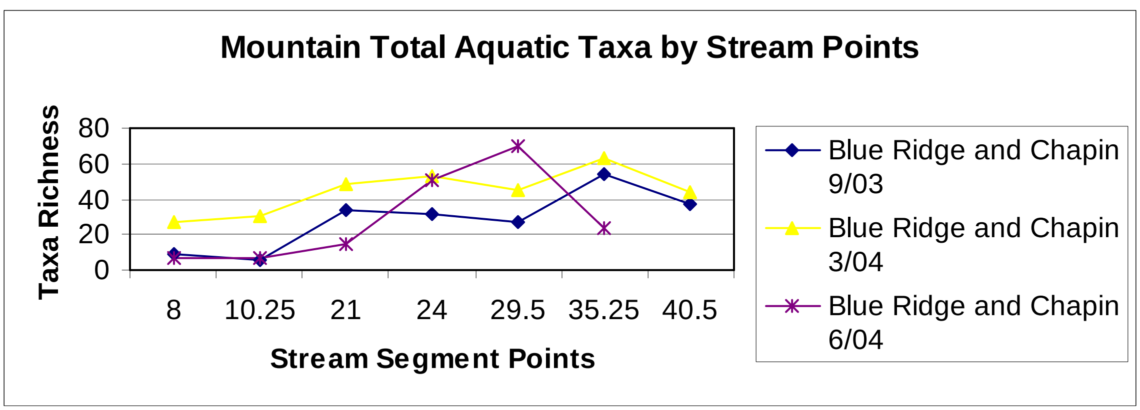
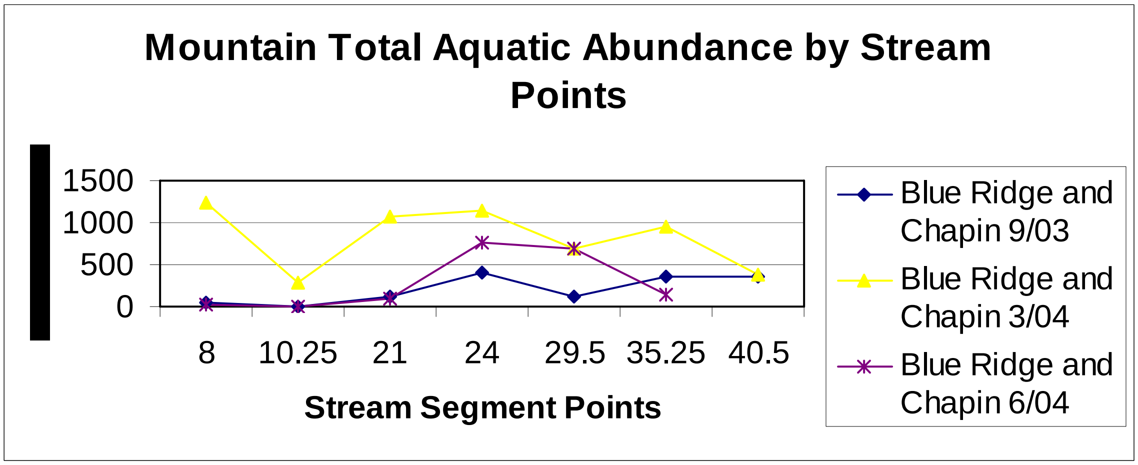


Figure 7. Aquatic Abundance in Mountain Streams.



Aquatic life and intermittent Streams in the Coastal Plain

Most streams in the coastal plain have been ditched sometime in the 350 years Europeans have been settled in the area. Of the few natural streams we could find, many natural headwater streams in the coastal plan start as a broad wetland until a feature on the landscape, usually two trees close together, constricts the wetland, flow begins and a channel is formed, however a few, mostly in the Sandhills, start as springs. Most of the observations of headwater streams in the piedmont and mountains apply to the coastal plain as well. The percent of aquatic taxa, taxa richness and aquatic taxa abundance all increase with stream permanence. Aquatic taxa with life cycles of a year or more are rare in streams scoring less than 30 points, except when the stream starts as a spring, when a perennial stream can score as low as 17 points.

Figure 8 is a graph of the aquatic abundance for the first year of study in the coastal plain. It demonstrates the same pattern observed in mountain and piedmont streams – that fewer aquatic taxa can survive in streams as they dry. The other interesting observation is that it appears that intermittent segments in the coastal plain actually support more aquatic live then small perennial segments. This may be an artifact of a single year of sampling, or it may reflect the opportunistic nature of many intermittent species that can quickly reproduce and maintain high numbers while there is water to support them.

Summary of Biology

Figure 9 is a summary of the average number of aquatic species in ephemeral, intermittent and perennial stream segments regardless of season or ecoregion. Despite large error bars around the intermittent and perennial segments, mostly due to variability from wet and dry years, the pattern of increasing aquatic life in streams as water duration increases. Ephemeral channels have approximately 10-20% of the aquatic life (taxa richness or abundance) in perennial streams, while intermittent streams have 50-70% of the aquatic life of perennial streams.

Figure 8. Aquatic Abundance of Coastal Plain Streams 2007.

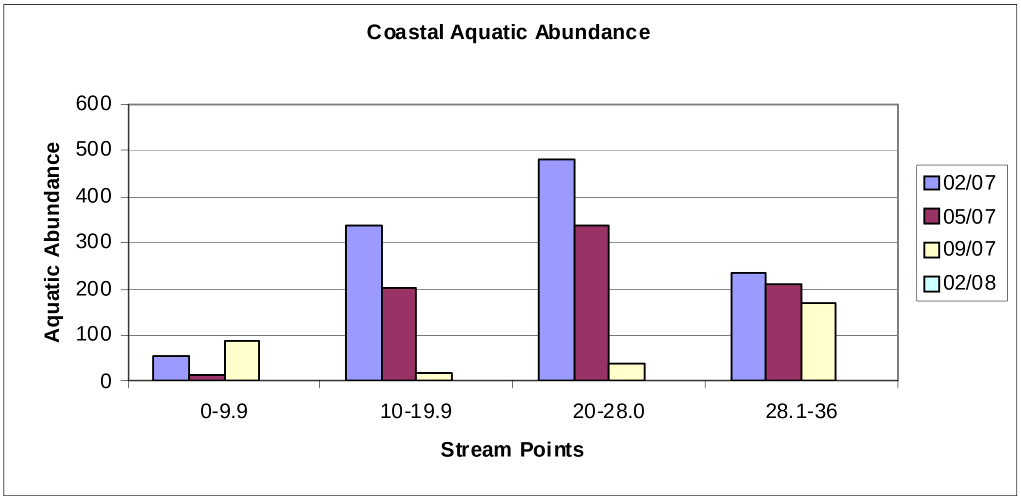
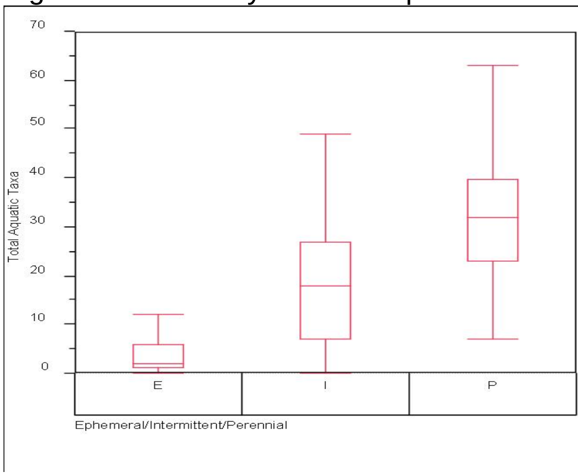


Figure 9. Summary of Total Aquatic Taxa for all Seasons and Ecoregions



Mitigation in other States

A survey was conducted to see which, if any, other states require mitigation for intermittent streams. If other states were successfully requiring mitigation for intermittent streams, we could learn from them mitigation methods that did or did not work well. Table 1 is a list of the seven states that responded to our survey. All of the responding states treat intermittent and perennial streams the same in terms of requiring mitigation. South Carolina defers to the Corps concerning when impacts require mitigation. All other states make their determinations independent of the Corps. South Carolina and Georgia have no minimum threshold of impacts, below which mitigation is not required. North Carolina has a threshold of 150 feet and Virginia has a threshold of 300 feet. The other states in this survey (Kentucky, Tennessee, Ohio and Oregon) all base their mitigation on a calculation of the lost ecological or functional values of the stream.

Table 1. Mitigation for Intermittent Stream Loss in Other States.

State	**NC**	**SC**	**VA**	**GA**	**KY**	**TN**	**OH**	**OR**
Treat Intermittent & Perennial same?	N	Y	Y	Y	Y	Y	Y	Y
Require Mitigation for Intermittent?	N*	Y*	Y	Y	Y	Y	Y	Y
Threshold (ft)	150	0	300	0	@	@	@	@

*Determined by Corps for both intermittent and perennial
@ Depends on functional value of resource lost

Stream impact versus stream mitigation in North Carolina

The Annual Reports of the Wetlands Restoration Program and the Ecosystem Enhancement Program provide the best measure of the current status of stream impact versus mitigation in NC. These reports (now all done by the Ecosystem Enhancement Program) compile all known stream and wetland impacts as well as the known compensatory and non-compensatory mitigation done in NC by fiscal year. Table 2 summarizes the data from these reports.

These reports clearly show that there has been a large net loss of stream length in NC over the past seven years. While Table 1 shows that, on average, only 40% of the stream length that is impacted is replaced by mitigation, this does not include EEP non-regulatory mitigation which usually adds 15-40% to mitigation totals annually. Unfortunately, EEP stopped tracking this separately in 2004 so they could not be factored into this table. This pattern is fairly constant over the last nine years and does not show any sign of approaching a balance. In other words, the goal of “no net loss of streams” is not being achieved in North Carolina. To achieve no net loss of streams, either fewer stream impacts will need to be permitted or more mitigation will need to be required or both. All of the stream impacts examined above have gone through the 404/401 permitting process and are therefore, arguably, unavoidable.

Table 2: Summary of stream impact versus mitigation by state fiscal year in NC (feet)

Fiscal Years	Impacts	Mitigation	Net Loss	% mitigated
1999-2000	169,937.00	85,378.00	-84,559.00	50%
2000-2001	216,880.60	78,881.25	-137,999.35	36%
2001-2002	208,588.90	86,680.40	-121,908.50	42%
2002-2003	280,732.00	132,749.00	-147,983.00	47%
2003-2004	279,083.80	124,923.80	-154,160.00	45%
2004-2005	465,483.80	186,060.00	-279,423.80	40%
2005-2006	259,165.82	139,488.50	-119,677.32	54%
2006-2007	234,978.16	92,510.80	-142,467.36	39%
2007-2008	401,847.04	82,549.00	-319,298.04	21%
Total	2,516,697.12	1,009,220.75	-1,507,476.37	40%

Recent Mitigation (2004 and 2005)

A 20% subsample of permits issued in 2004 and 2005 was taken to provide a more precise analysis (Tables 3 and 4). All impacts in this subsample come from DWQs paper files, Basinwide Management System (BIMS) or Corps of Engineers mitigation records. Appropriate project impacts and mitigation requirements were crosschecked with EEP data and files. Perennial impact values include all perennial impacts, whereas intermittent impact values are only for projects larger than 150 feet, which would require mitigation under this proposed policy. Intermittent impacts of smaller size are not included to facilitate an analysis of the cost of implementing this policy change.

Patterns of impact were very different between 2004 and 2005. While DOT perennial impacts declined 62% between 2004 and 2005, the rate of mitigation for these streams remained stable (76-78%). On the other hand, non-DOT perennial impacts rose nearly 40% from 2004 to 2005, but the rate of mitigation doubled from 40 to 80%. For all perennial impacts, in 2004 DOT created 81% of the impacts and paid 89% of the mitigation. In 2005, both the perennial impact and mitigation were about evenly split between DOT and non-DOT projects.

Table 3. Summary of stream impacts in 2004 (from a 20% subsample).

	Perennial Impacts	Perennial Mitigation	%	Intermittent Impacts	Intermittent Mitigation	%
DOT Impacts	183,000	138,800	76	4,100	0	0
Non-DOT Impacts	43,000	17,400	40	19,100	7,600	40
Total	226,000	156,200	69	23,300	7,600	33

There was also a large amount of between-year differences in impacts and mitigation to intermittent streams. In 2004, the DOT was responsible for only 18% of the total intermittent impacts while non-DOT projects accounted for the other 72%. The Corps required mitigation for only 1/3 of these impacts – none from DOT and for 40% of the non-DOT impacts. In 2005, impacts to intermittent streams approximately doubled. However the rate of DOT impacts was little changed (18% in 2004 to 23% in 2005). The rate of mitigation for intermittent stream impacts (84% overall) was much higher in 2005; 38% for DOT (up from 0% in 2004) and 97% mitigation for non-DOT projects (up from 40% in 2004). It is unlikely that these differences are due to accounting discrepancies, since the same method was applied by the same person and all values came from the same Corps database. It therefore appears that the between year differences in intermittent impacts and mitigation rates are real, which makes for large between-year differences.

Table 4. Summary of stream impacts in 2005 (from a 20% subsample).

	Perennial Impacts	Perennial Mitigation	%	Intermittent Impacts	Intermittent Mitigation	%
DOT Impacts	69,300	54,100	78	10,900	4,100	38
Non-DOT Impacts	68,800	55,000	80	37,000	35,900	97
Total	138,100	109,100	79	47,900	40,000	84

Cost of policy implementation.

While there is great variability in intermittent impacts and mitigation rates between years, these values can allow a range of values for what implementing policy can cost, and what it can achieve in terms of meeting a no net loss goal for stream impact, at least until developers and engineers adapt to the new policy and additionally minimize perennial stream impacts. With the new policy, DOT would be required to do an additional 4,100 – 6,800 feet (mean 5,450 feet) of stream mitigation credit per year, while non-DOT projects would be required to conduct from 1,100 – 11,500 feet (mean 6,300 feet) of additional stream mitigation annually. Therefore, this 11,750 (sum of mean values) feet of additional stream mitigation could make a significant improvement toward balancing stream impact and mitigation in North Carolina.

Summary

It is clear that intermittent and perennial headwater streams are very valuable in terms of pollutant (nutrients, sediment, etc.) removal and carbon (food) inputs that support aquatic life throughout the length of the stream. Finally, from this study, it is also clear that intermittent streams in North Carolina have significant aquatic life. Furthermore, the State is losing these streams at a faster rate than mitigation can replace them with present policies. Requiring mitigation at a one-to-one ratio will be a positive step toward achieving the goal of no net loss of streams in North Carolina.

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