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In Support of **S.B. No. 123**, AN ACT CONSERVING NATURAL VEGETATION NEAR WETLANDS AND WATERCOURSES

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My research at Connecticut College focuses on river dynamics and informs my testimony in support of S.B. No. 123

Our state's waterways are intricately linked to the vegetation that surrounds them. In most ecosystems in the state, large trees grew along the sides of rivers on the floodplain in what is termed, a riparian forest. The cumulative impact of human activities on New England channels is staggering. Nationwide, at least 70 percent of the original area of riparian forest was cleared (Swift, 1984). In Connecticut, the number percent of cleared riparian forest was even higher. Although trees now appear along many rivers and streams, the history of clearing trees has and continues to negatively impact aquatic habitat and water quality of our states watercourses (Thompson, 2006). Therefore, it is imperative that the State takes measures to protect the riparian forest area, by setting up buffer areas along rivers, to permit the natural healing process already underway in many rivers and streams. In the document below, I try to explain exactly how riparian vegetation, especially forest areas, has a direct impact on the physical conditions in the State's rivers and streams.

Traditionally, buffer areas along wetlands are valued world-wide for their ability to reduce runoff and filter pollutants out from surface runoff before the reach the sensitive wetlands areas (Gregory, 1991; Sweeney, 1992; Sweeney et al., 2004; Correl, 2005; Parkyn et al., 2005; Hussein et al., 2007; Thompson et al., 2009; Veum et al., 2009). A great deal of literature exists on this subject, and other scientific experts will undoubtedly touch on this issue. This filtering function is clearly an important role of a buffer strip, but I wanted to highlight another extremely important, but often overlooked role that riparian trees play in rivers and streams.

Scientific research has shown that the type of vegetation has an impact on the size, especially the width, of an adjacent stream or river (Zimmerman et al., 1967; Sweeney, 1992; Hey and Thorne, 1996; Gregory and Gurnell, 1988; Hession et al., 2003; Sweeney et al., 2004; McBride et al., 2006). The mechanisms that control behavior in the rivers are complex (McBride et al., 2006), but it is clear that clearing riparian forests directly impact the physical conditions in the adjacent river. Therefore, it is impossible to consider a wetland, especially a stream or river as separate and unrelated to the conditions that exist in the riparian area.

Pools and riffles are one of the most common and recognizable bedform sequences in channels (Thompson, 2003). These features are critical for aquatic habitat because they provide living space for both fish species and macroinvertebrates (Hunter, 1991; Gordon et al., 1992; Kondolf and Micheli, 1995; Morris, 1995; Newbury, 1995; Thompson, 2003). In the most basic sense, pools are classified as deep areas with low velocities at low stage, while riffles exhibit higher water-surface slopes and faster velocities (Thompson, 2003). The relative proportion of pool versus riffle area is a particularly important characteristic of aquatic habitat, and is a function of both pool spacing and length of individual pools (Myers and Swanson, 1997; Buffington et al., 2002; Thompson, 2006). Therefore, the State should be particularly concerned with anything that adversely impacts the development and continued existence of pools and riffles in the waters of Connecticut.

Scientists recognize that a stream flowing through forests with large trees has many pools formed by constrictions associated with dead wood that has fallen into the river (Montgomery et al. 1995; Thompson, 1995; Abbe and Montgomery, 1996; Myers and Swanson, 1997; Thompson and Hoffman, 2001). Wood acts as local hydraulic controls and forms forced pools over decades and possibly centuries (Abbe and Montgomery, 1996). Although only a small portion of the wood pieces tend to create pools, the frequency of these pools is directly influenced by the number of wood pieces (Montgomery et al. 1995; Richmond and Fausch, 1995; Wood-Smith and Buffington, 1996). Similarly, Buffington et al. (2002) indicate that more obstructions create more pool scour and greater total area of pools. Studies on pools include many reports of over 80 or 90 percent of pools being associated with structural controls and large obstructions that include boulders, bedrock outcrops and wood (Dolan et al., 1978; Lisle, 1986; Montgomery et al., 1995; Richmond and Fausch, 1995; Wood-Smith and Buffington, 1996; Thompson, 2001; Wohl and Legleiter, 2003). Loss of wood from rivers has been linked to loss of pool habitat area (Lisle, 1995). If the State wants to protect aquatic habitat, it is clear that the role of wood in rivers must be considered.

Richmond and Fausch (1995) found that wood pieces forming pools had significantly larger diameters and lengths than those pieces not forming pools. The diameter of the logs is largely a function of the age of the forest stand, which is often a direct result of the logging history (Likens and Bilby, 1980). Likens and Bilby (1980) suggest that wood created pools in New Hampshire may take over 100 years to return to pre-disturbance levels in channels of third order and greater, and might take up to 500 years before steady-state conditions of timber recruitment were reestablished. In another New England channel, Thompson (1995) showed a correspondence between the volume of standing timber and the volume of wood in rivers. Based on field data of tree diameter and channel width, Likens and Bilby (1980) predicted that mature tree species common in New Hampshire should be capable of forming wood created pools on channels as wide as 30 feet. However, channels of this size were completely devoid of wood created pools even 60 years after logging activities ceased (Bilby and Likens, 1980; Likens and Bilby, 1980). Therefore, it is important for the state to continually protect riparian areas to insure trees can attain the larger sizes needed to produce pools in many systems.

Once the wood is introduced to a stream, the wood is then subject to redistribution by the river flow. Wood diameter and length both influence log stability and distance of movement (Likens and Bilby, 1980; Nakamura and Swanson, 1993; Beechie et al. 2000; Braudrick and Grant, 2001). Log stability is a necessary condition to form stable pools, so the minimum length and diameter of wood capable of creating pools in relation to channel characteristics should be sensitive to the nature of the riparian forest and the related logging history. Once again, larger logs are needed to form pools in larger rivers. Once again, protection of riparian vegetation through the establishment of buffer strips is critical to provide the wood utilized for formation of aquatic habitat used by fish and macroinvertebrates.

Excess sediment in streams is considered one of the most common negative impacts on water quality in the nation's streams and rivers (EPA, 2008). Wood in a river also has a large positive impact on sediment input and storage that helps improve water quality. Wood creates instream (Lisle, 1986) and overbank sediment storage sites (Gurnell and Gregory, 1984) that can contain from 123 percent of the stream's annual sediment yield (Marston, 1982) to between ten and fifteen times the annual sediment yield (Megahan and Nowlin, 1976; Swanson and Lienkaemper, 1978; Megahan, 1982; Swanson and Fredriksen, 1982). Wood also provides temporary-storage areas for new sediment pulses (Keller and Tally, 1979). Chin (1989) and Thompson (1995) described deposition of fine-grained sediment upstream and an armored channel-bed downstream from wood positioned across small channels. Klein et al. (1987) have also noted that wood can limit vertical erosion of a stream bed and stable sediment storage sites. Wood residence times in excess of 20-100 years have been suggested (Swanson and Lienkaemper, 1978; Megahan, 1982; Swanson et al, 1984; Hogan, 1987; Kelsey, 1987; Madej, 1987), which shows that long-term storage of sediment can occur. Researchers have also noted the ability of wood to protect channel banks from erosion (Marston, 1982). Therefore, an adequate supply of wood to a river can have an important role in improving water quality.

One extremely important question centers on the size of the buffer needed to protect a wetland. Why in particular is 100 feet considered a reasonable size? The width of a buffer intended to function as a runoff and pollutant filtering mechanism is related to the slope of the valley walls (Hussein et al., 2007). Once again, other scientists can provide references specific to filtering. Another major consideration is the expected height of fully mature trees that will eventually supply a source of wood to a river. Several species of trees are capable of growing to heights of 100 feet and more. Leverett (1999) reports that White Pine in access of 150 feet were not uncommon in the river valleys of New England in pre-colonial times. Furthermore, Sugar Maple, Eastern Hemlock and American Sycamore may have reached heights of 100 feet and more with some frequency (Leverett, 1999). Leverett (1999) lists a total of 16 species of trees found in Massachusetts that currently have individual trees that exceed 100 feet in height. Given these numbers, it is clear that a minimum of a 100 foot buffer is needed to encompass the area that could potentially supply wood to a stream or river. Although the chance of a tree 100 feet away falling into the river may seem small, the common condition where the sides of the valley slope towards the river, make it more likely for trees to fall towards the river than away. If we consider the fact that a river is also likely to adjust laterally over time, it becomes quickly evident, that a 100 foot buffer is barely adequate to ensure a continued supply of wood to a river or stream.

As I have tried to document above, riparian vegetation has a direct impact on the width of channels, the percent of area occupied by critical pool habitat, and the volume of potentially detrimental sediments stored in beneficial locations. The suggested 100 foot width has sound scientific basis given the height of trees expected in mature riparian forests. Historic loss of wood from Connecticut rivers may be one of the most harmful legacies of development impacting local wetlands in the state. The establishment of vegetated buffer strips, especially forested buffer strips, can have beneficial impacts on the State's waterways that can last for decades.