Referenced List of the Benefits of Woody Debris in Streams, and a List of the Negative Impacts of Indiscriminate Debris Removal

Below is a review of the documented benefits of having large woody debris in streams (and a few other miscellaneous facts), taken from the papers in my files. The best overview papers of the different roles woody debris plays in streams – pro and con – are probably Gregory and Davis, 1992 (especially Figure 1, p. 127), Gurnell et al., 1995, and Piégay and Gurnell, 1997.

Stream Channel Formation and Erosion

- **Stable woody debris increases the stability of a stream channel by absorbing the energy of flood flows, reducing water velocity at low and moderate flows, and reducing erosion of the stream bank and stream bed at both local and regional scales**
    - Abbe and Montgomery, 1996; Ehrman and Lamberti, 1992; Gurnell et al., 1995; Hygelund and Manga, 2003; Keller et al., 1995; Keller and Macdonald, 1995; Manga and Kirchner, 2000; Marston, 1982; Piégay and Gurnell, 1997; Smith et al., 1993a; Wallace et al., 1995
- **Stable woody debris affects channel form by slowing and directing flood flows and temporarily storing sediment**
    - Bilby, 1984; Diez et al., 2000; Gurnell et al., 1995; Keller and Swanson, 1979; Marston, 1982; Mutz, 2000; Piégay and Gurnell, 1997; Smith et al., 1993a; Thompson, 1995
- **Embedded woody debris (stumps rooted into the stream bank, logs stuck into the stream bed) reduce local bank erosion**
    - Keller and Swanson, 1979
- **Removing woody debris decreases critical shear stress and increases channel bed erosion (to maintain channel slope)**
    - Assani and Petit, 1995; Heede, 1985; Smith et al., 1993b
- **In larger natural streams, woody debris is usually oriented to the flow such that it does not reduce flow conveyance or increase flooding frequency.**
    - Gippel et al., 1996a
- **Water flow blockages may be reduced by rotating woody debris, rather than removing it (laboratory flume study)**
    - Young, 1991
- **Woody debris occupying less than about 10% of the stream channel width does not reduce flow conveyance (field study)**
    - Gippel et al., 1996b
- **Stream blockages as high as 50% cause only a 1% rise in base flow stage levels (laboratory flume study)**
    - Young, 1991
- **Stream blockages as high as 80% are required to significantly increase flood levels (laboratory flume study)**
    - Young, 1991

- **Woody debris higher in the water column causes less flow blockage than logs positioned along the bottom (laboratory flume study)**
    - Young, 1991
- **Stable woody debris can reduce erosion of exposed stream banks and channel bars by protecting developing thickets of riparian vegetation, for decades or even centuries**
    - Abbe and Montgomery, 1996; U.S. Forest Service, 1988

Fish

- **A greater variety of fish occur in streams with woody debris**
    - Montgomery and Piégay, 2003; Piégay and Gurnell, 1997; U.S. Forest Service, 1988; WAWRC, 2000
- **Woody debris causes the formation of good fish habitat such as pools, backwaters and fast-flowing chutes, in small to mid-size streams**
    - Andrus et al., 1988; Baillie and Davies, 2002; Beechie and Sibley, 1997; Bilby and Bisson, 1998; Bilby and Ward, 1991; Carlson et al., 1990; Collins and Montgomery, 2002; Gurnell et al., 1995; Hilderbrand et al., 1997; Hunt, 1993; Keller et al., 1995; Keller and Macdonald, 1995; Ralph et al., 1994; Richmond and Fausch, 1995; Tasmanian Inland Fisheries Service; U.S. Forest Service, 1988, 1989.
- **Woody debris provides fish "refuges" during floods**
    - Gurnell et al., 1995; McMahon and Hartman, 1989; U.S. Forest Service, 1988
- **Woody debris provides nursery habitat for juvenile fish**
    - U.S. Forest Service, 1984; U.S. Forest Service, 1988
- **Woody debris jams temporarily store sediment, reducing siltation of fish habitat like riffles and pools, and increasing the variety of stream habitats**
    - Bilby and Bisson, 1998; Keller et al., 1995; Keller and Macdonald, 1995; Keller and Swanson, 1979; U.S. Forest Service, 1988
- **Debris jams help streams retain organic materials (leaves, small sticks), which is food for macroinvertebrates and fish**
    - Bilby and Likens, 1980; Ehrman and Lamberti, 1992; Piégay and Gurnell, 1997
- **Large woody debris increases the diversity of habitat types in streams of all sizes**
    - Gurnell et al., 1995
- **Large pools containing pieces of woody debris contain more fish than pools without woody debris**
    - Flebbe, 1999.

Macroinvertebrates

- **Woody debris increases macroinvertebrate production and diversity**
    - O'Connor, 1991; Piégay and Gurnell, 1997; Smock et al., 1985; Smock et al., 1989; Smock et al., 1992

- **Woody debris provides shelter and food to macroinvertebrates, which in turn are important food for fish.**
    - Benke and Wallace, 1990; Bilby and Bisson, 1998; Gurnell et al., 1995; Hilderbrand et al., 1997; Piégay and Gurnell, 1997; Tasmanian Inland Fisheries Service Fact Sheet; U.S. Forest Service, 1984; Wallace and Benke, 1984; WAWRC, 2000
- **Decaying woody debris releases nutrients and organic materials into the stream that benefit macroinvertebrates**
    - Piégay and Gurnell, 1997; Smock et al., 1989; U.S. Forest Service, 1984; U.S. Forest Service, 1988

Negative Impacts of Indiscriminant Woody Debris Removal

(according to Gregory and Davis, 1992 [mostly], and others)

- Decreased stream channel stability
    - Increased downcutting
    - Increased scouring
    - Channel widening
    - Local bank erosion
- Decreased volume, depth and number of pools
- Increased stream velocity and shear stress
- Reduced capacity to retain and process organic matter (food for bugs and fish)
- Release of sediment from behind debris jams
- Reduced macroinvertebrate and fish production
- Reduced quality of fish habitat
    - Loss of winter cover
    - Loss of flood refuges
    - Loss of food organisms
    - Loss of juvenile fish rearing areas

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Also see the extensive annotated terrestrial and aquatic woody debris bibliography maintained by the U.C.-Berkeley Center for Forestry:
www.cnr.berkeley.edu/forestry/woodbiblio.html