Section 5

TEMPERATURE EFFECTS IN BROWNWATER STREAMS

An annotated bibliography

Compiled for the
Region II Forest Resources and Practices Science and Technical Committee

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SUMMARY

Brownwater streams drain low-lying peat soils and are marked by stained water, high dissolved organic carbon, and (usually) acidic pH (Clifford 1969; Milner et al. 1997). These streams tend to have low channel slope and high hydrologic residence time which, coupled with the thermal absorbance of stained water, predisposes them to relatively warm summer temperatures (USFS 1986).

The objective of this review is to compile literature describing the susceptibility of brownwater streams to elevated temperatures, particularly in reference to riparian management strategies. However, little research has addressed northern brownwater stream habitats and no studies have addressed the influence of timber harvest on brownwater streams in Region II. For practical purposes, I included in this review research from northern streams draining significant wetland areas regardless of whether the stream was reported as brownwater or not.

Some studies have shown naturally-occurring high temperatures in northern lowland and brownwater streams. Monitoring data in Alaska have shown temperatures in excess of state water quality standards (13°C for fish spawning and incubation, 15°C for migration routes) in streams draining extensive wetlands (Mauger 2003), with temperatures over 20°C recorded in the Deshka River (Kyle and Brabets 2001). Alberta brownwater streams showed maximum summer temperatures of >16°C (Clifford 1969) and 20°C (McElhone et al. 1987).

Climatic models for Cook Inlet basin streams suggest that lowland (i.e., brownwater) streams are especially susceptible to warming as atmospheric CO_2 levels rise (Kyle and Brabets 2001).

Increased stream temperatures have been associated with timber harvest in southeast Alaska (see Murphy and Milner 1997). Streams in other areas of Alaska are more

susceptible to high temperatures due to warmer summers and more sunny days (Gibbons et al. 1987).

REFERENCES

Clifford, H.F. 1969. Limnological features of a northern brown-water stream, with special reference to the life histories of aquatic insects. American Midland Naturalist 82:578–597.

This paper gives physico-chemical data from an Alberta brownwater stream. Summer water temperatures >16°C were recorded.

Kyle, R. E. and T. P. Brabets. 2001. Water temperature of streams in the Cook Inlet basin, Alaska, and implications of climate change. USGS Water-Resources Investigations Report 01-4109.

This analysis first modeled the relationship between air temperature and stream temperature for those Cook Inlet basin streams with sufficient historical water temperature data (n=32). The authors then used climate change models to predict increases in air temperature based on a doubling of atmospheric CO_2. With these models the authors predicted increases in stream temperature in response to the projected increased air temperatures.

According to the climate models, mean annual temperature will increase 7.2°C in the northern half of the basin and 8.5°C in the southern half of the basin with a doubling of atmospheric CO_2. The largest increase in air temperature will occur in the winter. Fifteen streams were projected to show >3°C weekly mean temperature increase, and these tended to be the warmer (i.e., lowland) streams. Beaver Creek (near Kenai) and the Deshka and Ninilchik rivers showed the greatest projected temperature increases (≥5.3°C). The Deshka River showed the highest observed (20.6°C) and projected (24.6°C) maximum weekly temperature. Temperatures fatal to salmon will not likely be reached with a doubling of atmospheric CO_2, but infections may increase.

Mauger, S. 2003. A preliminary water quality assessment of lower Kenai Peninsula salmon-bearing streams. Cook Inlet Keeper. Homer, AK.

This report summarizes physico-chemical monitoring data collected between 1998 and 2003 from 12 sites in the Ninilchik River, Deep Creek, Stariski Creek, and Anchor River basins. Wetlands dominate each of these basins, comprising >50% of the Deep and Stariski basins and nearly 100% of the Anchor and Ninilchik basins. Each of these streams showed summer water temperatures in excess of 15°C (Alaska water quality standard upper limit for fish migration), with Anchor River showing the highest summer temperature (17.6°C). The author compared her data with historic USGS data (1950–1970) and found temperatures to be similar across time.

McElhone, M.J., R.W. Davies, J.M. Culp. 1987. Factors influencing the abundance of Trichoptera in Hartley Creek, a brownwater stream in northeastern Alberta, Canada. Archiv fur Hydrobiologia 109:279-285.

This paper compared physico-chemical data and caddisfly emergence between a year of high water and a year of low water. Stream temperature was generally higher during the high water year, reaching a maximum of 20°C.

Murphy, M.L. and A.M. Milner. 1997. Timber harvest and fish habitat. Pages 229-263 *in* A.M. Milner and M.W. Oswood (editors). Freshwaters of Alaska: ecological syntheses. Springer.

Murphy and Milner reviewed studies of timber harvest influences on stream temperature in southeast Alaska. Removal of forest canopy can increase average stream temperature as well as diurnal fluctuations. Although 2 of the studies reviewed showed no increase in stream temperature with logging (James 1956; Harris 1960), studies generally showed modest temperature increases (Meehan et al. 1969). One study showed small clear-cut streams approaching temperatures lethal to salmonids (Tyler and Gibbons 1973). Temperature increases were positively correlated with the surface area of stream exposed to sun and negatively correlated with discharge (Beschta et al. 1997).

Data from Southeast streams may not be directly applicable to Region II streams. Although many Southeast streams are brownwater, the steep stream channels (i.e., reduced hydrologic residence) typical of this region may mitigate temperature sensitivity. Furthermore, streams in other areas of Alaska are more susceptible to warming due to higher summer temperatures and more sunny days (Gibbons et al. 1987).