# Section 6

# EFFECTS OF BEETLE EPIDEMICS AND HARVESTING ON STREAM FLOW

**An annotated bibliography**

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

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## SUMMARY

There have been few studies analyzing the effects of bark beetle outbreaks on stream hydrology. No studies have been undertaken in Alaska. The most pertinent studies to south-central Alaska's spruce beetle epidemic of the 1990's come from evaluations of stream flow after a large Colorado spruce beetle outbreak in the 1950's (Bethlahmy 1974, 1975 and Mitchell and Love 1973). Substantially greater water yields were still evident 25 years after this outbreak as significant numbers of dead trees still occupy the land and have not been replaced by live trees. The largest increases in stream flow occurred 15 years after the outbreak. A mountain pine beetle outbreak in Montana resulted in significant increases in annual water yield, advances in the annual hydrograph, and an increase in low flows (Potts 1984).

The hydrologic effects resulting from removal of vegetation along streams, whether by fire, harvesting, or beetle epidemics will affect stream flow. Common effects include: higher and earlier annual peak flows (= advancement in time of the major snowmelt runoff), and increased water yield (Cheng 1980, 1989; Hibbert 1965). Reforestation of impacted areas will decrease water yield.

Montana, Utah, and Idaho are states (there may be others) that allow restricted management in riparian areas (= Stream Protection Zones) (Anon. 1994, 2000). Where riparian areas are protected under Forest Practices Acts, effects of timber harvest on fish habitat is minimal (Colla and DuPont 2000; Tydingco 1999).

## REFERENCES

**Anonymous. 1994. Montana: Streamside management Zone Law & Rules. Montana Department of State Lands, Missoula, Montana. 34p.**

Motorized equipment prohibited in SMZs, but three exceptions for Class I, II, and III streams (e.g., frozen ground, etc.). Clearcutting is prohibited in SMZs and there are tree retention requirements.

**Anonymous. 2000. Rules pertaining to the Idaho Forest Practices Act Title 38, Chapter 13, Idaho Code. Idaho Department of Lands, Boise, Idaho. 32p.**

There are Class I and Class II Stream Protection Zones (SPZ); Class I with a minimum of 75' from high water mark and Class II with a minimum of 30' above high water mark. On slopes exceeding 45% gradient adjacent to Class I or II, ground based skidding shall not be conducted except with an approved variance. Harvesting can take place in either Class I or II SPZs. There are standards governing the minimum number of residual trees to be left per 1000' feet of stream.

**Anonymous. 2000. Forestry for Idaho. BMP's. Forest Stewardship Guidelines for Water Quality. University of Idaho, Cooperative Extension System. 32p.**

Chapter 2 deals with streamside management. SPZs are not timber harvest "keep out" zones. But they are locations where timber harvesting activities must be modified to protect stream values. If harvesting is allowed: Leave 75% of the existing shade adjacent to streams; use directional falling for harvest operations in the SPZs; consider hand-scalping and planting within SPZs, equipment is not allowed in SPZs or wet areas; whole-tree or tree-length yarding is encouraged; standing trees in SPZs, including hardwoods, conifers, and snags will be left within 50' of the ordinary high water mark on each side of all Class I streams with specific numbers of trees per 1,000' of all streams.

**Bethlahmy, N. 1975. A Colorado episode: beetle epidemic, ghost forests, more stream flow. Northwest Science, Vol. 49, No. 2: 95-105.**

When a small watershed is clearcut, it temporarily yields more water. The implication is that water yield and land use are closely related. This interdependence is illustrated for two large watersheds in Colorado where bark beetles destroyed the living timber trees. Substantially greater water yields are still evident 25 years after the epidemic because significant elements of the watersheds have not reverted to their former status---dead trees still occupy the land, and have not been replaced by live trees. The variable hydrologic effects of the epidemic in the studied watersheds reflect differences in their exposures.

**Bethlahmy, N. 1974. More streamflow after a bark beetle epidemic. Journal of Hydrology, 23: 185-189.**

A beetle epidemic near the Continental Divide in Colorado destroyed the timber in two large drainages but bypassed a third drainage. Long-term streamflow records were available for the three drainages for the periods before and after the onset of the epidemic. Analysis of these records reveals that a major increase in stream flow occurred after the epidemic. The smallest increases on both drainages occurred during the first 5-yr. period (when the beetle population was multiplying to epidemic proportions); the largest increases occurred 15 yrs. later.

**Cheng, J.D. 1980. Hydrologic effects of a severe forest fire. *In*: symposium on watershed management 1980; Boise, ID Jul 21-23, 1980. ASCE, Comments on Watershed Management, Vol. 1: 240-251.**

The hydrologic effects of a severe forest fire were assessed using streamflow data for one stream draining a small watershed (7 $mi^2$) with more than 60% of its area burned, and a nearby control stream draining a larger unburned watershed. The results indicate that changes in the hydrology of the burned watershed following the fire are characterized by: higher and earlier annual peak flows, the advancement in time of the major snowmelt runoff, and increases in total April-August water yield and monthly water yield during the late summer and fall period. These changes are the result of earlier and faster snowmelt, and a reduction in evapotranspiration loss from the burned watersheds.

**Cheng, J.D. 1989. Streamflow changes after clear-cut logging of a pine beetle-infested watershed in southern British Columbia, Canada. 1989. Water Resources Research, Vol. 25 No. 3: 449-456.**

The paired watershed technique was used to assess the streamflow changes of Camp Creek in interior British Columbia after clear-cut logging occurred over 30% of its 8400 ac. watershed. Existing hydrometric data for Camp Creek (beetle infested) and those of an adjacent control, Greata Creek (not beetle infested), were analyzed for both the 1971-1976 prelogging and 1978-1983 postlogging periods. Postlogging Camp Creek streamflow changes are characterized by increases in annual and monthly water yields and annual peak flows, as well as earlier annual peak flow and half flow volume occurrence dates. The direction and magnitude of these postlogging streamflow increases are clear and consistent. The results are in good agreement with the findings of most previous studies conducted on watersheds that generally have been smaller than 2.5 $km^2$. This study provides strong evidence that changes in streamflow from large forested watersheds can be significant if a sizeable portion of its drainage is clear-cut.

**Colla, J. and J. DuPont. 2000. Forest practices water quality audit, 1999. Idaho Department of Lands. (unpublished). 22p.**

Authors evaluated the extent that the Idaho Forest Practices Act protects bull trout habitat. Compared the habitat in recently logged stream segments where bull trout are known to occur with the habitat in stream reaches with known bull trout populations (reference streams). Authors inspected 26 timber sales (36 reference stream reaches) to assess rule implementation and effectiveness. Audit reaffirmed that if BMPs or rules are correctly implemented, they are effective at minimizing or avoiding impacts to affected resources. Most affected landowners recognize that streams with a high value fishery need additional care to avoid problems.

**Hibbert, A.R. 1965. Forest treatment effects on water yield. *In* W.E. Sopper and H.W. Lull (Eds.), International Symposium Forest Hydrology, p. 527-543. Pergamon Press, N.Y.**

Results are reported for thirty-nine studies of the effect of altering forest cover on water yield. Taken collectively, these studies reveal that forest reduction increases water yield, and that reforestation decreases water yield. Results of individual treatments vary widely and for the most part are unpredictable. First-year response to complete forest reduction varies from 34 mm to more than 450 mm of increased streamflow. A practical upper limit of yield increase appears to be about 4.5 mm per year for each percent reduction in forest cover, but most treatments produce less than half this amount. There is strong evidence that in well-watered regions, at least, streamflow response is proportional to reduction in forest cover. As the forest regrows, following treatment, increases in streamflow decline; the rate of decline varies between catchments, but appears to be related to the rate of forest recovery. Seasonal distribution of streamflow response to treatment is variable; response in streamflow may be almost immediate or considerable delayed, depending on climate, soils, topography, and other factors.

**Lambert, B. 2000. A preliminary water quality assessment of lower Kenai Peninsula salmon streams. Report prepared by Cook Inlet Keeper for Homer Soil & Water Conservation District. 68p.**

Water quality monitored at 12 sites on Ninilchik River, Deep Creek, Stariski Creek and Anchor River. Data collected demonstrate that 1) more monitoring is needed to document natural variability of water chemistry and suspended solids concentrations; 2) preliminary data collection suggests water quality is generally within Alaska's water quality standards; and 3) for the parameters compared, little change has occurred between 40 years ago and the present.

**Mauger, S. 2003. A preliminary water quality assessment of lower Kenai Peninsula salmon-bearing streams. Report prepared by Cook Inlet Keeper for Homer Soil & Water Conservation District. 94p.**

Cook Inlet Keeper and the Homer Soil and Water Conservation District have been monitoring water quality on Ninilchik River, Deep Creek, Stariski Creek, and Anchor River since August

1998 to document current water quality conditions and compare current conditions with the water quality standards that the State of Alaska has developed. Based on these data the water quality of the four rivers is high in general. However, some measurements for temperature and pH fall outside the ranges set by the State of Alaska to protect its water. Thirty percent of the total phosphorus measurements are above the level suggested by EPA for streams and rivers. Data from water temperature loggers suggest that water temperatures exceeded state standards more than 50 days during summer months. Extensive historical temperature data are not available so there is no way to be certain if these elevated temperatures are typical of these systems.

**Mitchell, M.E. and L.D. Love. 1973. An evaluation of a study on the effects on streamflow of the killing of spruce and pine by the englemann spruce beetle. Arizona Forestry Notes, School of Forestry, Flagstaff, AZ, No. 9: 19 pp.**

The death of the trees on the white River drainage significantly increased annual streamflow. A constant White River annual flow increment indicates that some type of stabilization is occurring on the watershed that is replacing the beetle-killed spruce and pine.

**Potts, D.F. 1984. Hydrologic impacts of a large scale mountain pine beetle (*Dendroctonus ponderosae* Hopkins) epidemic. Water Resources Bulletin, Paper No. 83122: 373-377.**

The Jack Creek watershed, a 133 $km^2$ drainage in southwestern Montana was impacted by a mountain pine beetle epidemic in 1975-1977, which killed an estimated 35% of its total timber. Analyses of USGS streamflow data for four years prior to and five years after mortality suggest a 15 percent post-epidemic increase in annual water yield, a 2-to-3 week advance in the annual hydrograph, a 10% increase in low flows and little increase of peak run-off.

**Tydingco, T.A. 1999. The effects of timber harvest practiced on fish habitat in Kenai Peninsula streams. University of Alaska/Fairbanks. MS Thesis. 53p.**

The effects of logging on fish habitat in streams of the lower Kenai Peninsula, Alaska during the summers of 1997 and 1998 were evaluated.  Large woody debris, riffle particle composition, and temperature were chosen as variables that would reflect fish-related changes in habitat that might result from logging.  Only temperature was significantly different (higher) in treatment areas. The logging operations that were investigated provided greater habitat protection than required by the Alaska Forest Resources and Practices Act.