Dog River Wild Trout Evaluations 2000-2015

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SUMMARY

A fifteen year study of wild trout populations in the Dog River observed substantial declines in the lower river despite implementation of restrictive anger harvest regulations. While changes in water quality, physical habitat, streamflow and angler harvest have been observed during the study period, there is no clear evidence that these factors were solely responsible for the decline in wild trout abundance within the Dog River. A near complete loss of wild rainbow trout in the upper Dog River suggests broad environmental variables may be the cause of these declines. Wild trout population increases in 2010 and again in 2015 are promising indications that the Dog River can continue to provide a quality wild trout fishery if managed conservatively.

BACKGROUND

The Dog River is a major tributary of the Winooski River located entirely within Washington County in central Vermont. It originates in the Town of Roxbury and flows north, approximately 20 miles through the towns of Northfield and Berlin before entering the Winooski River in the town of Montpelier. The Dog River drains an area of 94 mi^2 and its major tributaries include Felchner Brook, Bull Run, Stony Brook, Sunny Brook, Union Brook, Cox Brook and Chase Brook.

Early fisheries investigations of the Dog River and its tributaries included physical and chemical assessments (MacMartin 1959) and fish population surveys (MacMartin 1960, Kirn 1996) during the late 1950's to early 1960's. Additional fisheries assessments conducted in the early 1970's included angler surveys (Claussen 1971a) and trout population surveys of the mainstem and some major tributaries (Claussen 1971b, 1972). As a result of these investigations, fisheries management strategies included the stocking of catchable sized trout on a put-and-take basis in several locations. Brook trout *Salvelinus fontinalis* were stocked in the upper reaches of the Dog River (Roxbury to Northfield Village), Bull Run Brook and lower Cox Brook, while a mix of brook and brown trout *Salmo trutta* were stocked in the mainstem below Northfield Falls. Rainbow trout *Oncorhynchus mykiss*, the dominant trout component in the lower Dog River, continued to be managed as a wild trout resource. No stocking of this species has occurred within the Dog River or its tributaries since 1961 (Claussen 1972).

Trout population surveys of the Dog River and an angler creel survey of its lower reaches in 1991 prompted additional changes to the management of these fish populations. High densities of wild trout were generally found throughout the river and its tributaries, while angler catches of stocked trout in the lower river were poor (Kirn 1992). These observations led to the discontinuation of all trout stocking in the Dog River and its tributaries, which have been managed as wild trout streams since 1994.

Electrofishing surveys from 1991-2000 and angler creel surveys conducted in 1991, 1996 and 2000 characterized the Dog River as one of Vermont's most productive wild trout streams, supporting abundant populations of brook, brown and rainbow trout and sustaining a popular recreational fishery (Kirn 1992, 1998, 2000). These characteristics led to the selection of the Dog River as one of five wild trout streams targeted for special harvest regulations to improve the size and/or number of wild trout available to anglers (Kirn 2000b). Special regulations for a 4.3 mile section of the lower Dog River were initiated for the 2001 trout fishing season as follows:

Section: Railroad bridge in West Berlin to the first Route 12 bridge above mouth in Berlin; 4.3 miles
Length limit: 10 to 16 inch protected slot; all fish 10 to 16 inches must be released.
Creel limit: 2/day, only 1 can be greater than 16 inches.
Gear: No additional gear restrictions.
Season: Regular trout season.

This report presents the results of electrofishing surveys conducted since 2000 to monitor wild trout population levels in the Dog River and its tributaries, and to evaluate the effect of the special regulation.

PROCEDURES

Trout Population Surveys:

Trout population surveys consisted of single or multiple run electrofishing sampling with a 250/500 volt DC stream-side generator and/or Smith-Root Model 12 POW backpack electrofisher. Survey locations were sometimes limited by access and stream depth. Large, deep pools or runs could not be effectively sampled (Reynolds 1983), therefore surveys conducted in the middle and lower reaches of the Dog River may not be representative of actual trout population densities, but provide a relative index of trout abundance. In addition, some survey stations were not sampled annually due to changes in channel depth, width or channel blockages resulting from large wood deposition. This was particularly evident following the 2011 spring and summer flood events.

Captured brook trout, brown trout and rainbow trout were measured to the nearest mm (total length), weighed to the nearest g and released. Presence of other fish species was recorded.

Wild trout population estimates are presented as minimum estimates for single run surveys, or determined by the maximum weighted likelihood method developed by Carle and Strub (1978) for multiple run surveys. Trout population estimates are partitioned into five age/size classes: young-of-year (yoy); <6.0 inches; 6.0-9.9 inches; 10.0-11.9 inches; and 12+ inches. Population

estimates are presented as number of trout per mile for each trout species and size class present and pounds of trout per acre for all trout combined. Although no stocking occurred in the Dog River watershed since 1994, brown trout stocked in the Winooski River, distinguished by fin condition or fin clips, have been occasionally observed in some sections. Stocked trout were also measured and weighed but not included in population estimates.

The Dog River is fragmented by a series of three dams within the village of Northfield. The middle dam supports an operational hydroelectric facility, while the upper and lower dams are remnants of historic mill dams. All are fish passage barriers. For purposes of this report the upper Dog River is defined as the reach above of the most downstream dam in Northfield Falls, and the lower Dog River is located from the Northfield Falls dam to the confluence with the Winooski River.

Temperature Monitoring:

Temperature loggers (8KB Optic StowAway or HOBO ProV2; Onset Computer Corporation) were placed within or near electrofishing stations within the mainstem of the Dog River from 2000-2015. Temperatures were recorded on the hour, 24 hours per day, from June through September and results are presented for the number of days exceeding 65°F, 72°F, 75°F and 80°F as well as maximum temperature and 7 and 14-day rolling average daily maximum temperature.

RESULTS

Trout Population Surveys:

A total of 90 individual trout population surveys were conducted in the Dog River mainstem and an additional 67 surveys were conducted in tributary streams from 2000-2015 (Table 1).

Upper Dog River and Tributaries:

Station Elevation 1034': The upper station at elevation 1340' in Roxbury has been sampled seven times over the past 16 years (Table 1). This reach of the Dog River supports exclusively wild brook trout with population estimates which ranged from 907 trout/mile in 2011 to 3768 trout/mile in 2015 (Table 2). Biomass estimates during the same period ranged from 19.9 lbs/acre (2007) to 59.2 lbs/acre (2013; Table 2). These population and biomass ranges are reflective of high quality brook trout populations in Vermont (VDFW 1993).

Station Elevation 805': This station is located at the southern portion of the Northfield Country Club and has been sampled annually since 2000 (Table 1). Surveys from 1986 through 2006 observed a mixed population of wild brook, brown and rainbow trout in this reach. Population estimates ranged widely from 316 trout /mile in 2012 to 1738 trout/mile in 2013, while biomass estimates ranged from 4.8 lbs/acre in 2013 to 18.9 lbs/ace in 2000 (Table 3). Total trout biomass estimates observed in 2015 were the highest since 2000. Of significance during this time period is the complete loss of wild rainbow trout production since 2007. Rainbow trout were a major component of the wild trout community in earlier surveys from 1986 through the 1990's.

Substantial declines in wild trout population levels were observed in several Dog River tributaries following flooding during Tropical Storm Irene in 2011. Young-of year (YOY) trout

were reduced to 0-37% of pre-flood levels while older trout declined to 45-64% of pre-flood levels (Figures 1 & 2). Trout populations in Dog River tributaries rebounded in 2012 with very high YOY production (Table 5).

Stream Temperature: The upper Dog River stations maintained cold stream temperatures in all years sampled. Station 1340' temperatures exceeded 65°F for a total of 14 days in the three years sampled while maximum temperatures never exceeded 67°F (Table 4). Station 805' never exceeded 72°F in the nine years sampled with maximum temperatures exceeding 70°F in only two years. No trends in temperature metrics were evident over the sampling period.

Tributaries: Surveys of the upper Dog River tributaries generally revealed abundant wild trout populations often dominated by brook trout, but many also supporting wild rainbow trout and brown trout (Table 5). As observed in the Dog River station 805' a significant reduction or complete disappearance of wild rainbow trout was noted over the past decade, particularly in Bull Run, Cox Brook and Sunny Brook (Table 5).

Sunny Brook is the largest Dog River tributary and sustained an abundant wild trout population throughout the study period ranging from 574/mile (2003) to 1678/mile (2012) and 17.3 lbs/acre (2003) to 40.9 lbs/acre (2012; Table 5). Although once a significant component of the wild trout community, rainbow trout have not been observed since 2005.

Substantial declines in wild trout population levels were observed in several Dog River tributaries following flooding during T.S. Irene in 2011. Surveys conducted in 2011 before and after T.S. Irene revealed young-of year (YOY) trout were reduced to 27-37% of pre-flood levels while older trout declined to 50-64% of pre-flood levels (Figure 1 & 2). Trout populations in Dog River tributaries rebounded in 2012 with very high YOY production (Table 5).

Lower Dog River and Tributaries:

1991-2009

Two survey stations (elevation 555' & 530') have been sampled regularly since 1991. Beginning in 2000, four annual survey stations were established to evaluate the effect of the special fishing regulations on the Dog River with one upstream (elevation 572'), two within (555' and 530') and one downstream (515') of the special regulation section. These stations were sampled annually throughout most of the period from 2000-2016. High flows following T. S. Irene precluded sampling at all lower Dog River stations in 2011. In addition, sampling of station 555' was not feasible from 2011-2014 due to increased channel depths and widths resulting from 2011 flooding. Likewise, due to channel dimensions, station 515' was very difficult to effectively sample and was discontinued in 2013.

From 1991-1999 stations 555' and 530' revealed consistent and very abundant wild trout populations (Figure 3, Table 7 & 8) comprised largely of rainbow trout (81% and 72%, respectively, for trout >6"). Significant declines in the production of wild trout >6" was observed in stations 555' and 530' beginning in 2000 and in all four survey stations by 2003 (Figure 3, Table 6,7,8,9). Following a rebound in 2005, all stations continued to decline through 2009. Despite the implementation of more restrictive harvest regulations, from 2000-2009 trout

>6” in station 555’ and 530’ declined to 9% and 24%, respectively, of their average levels from 1991-1999. Station 555’ estimates for wild trout >6” exceeded 1000 trout/mile in 6 of 9 years from 1991-1999 but only exceeded 200 trout/mile in 2 years from 2000-2009. Large declines were also observed in stations 572’ and 515’ during this time.

Despite dramatic declines in larger trout, YOY rainbow trout production remained strong through 2009, averaging between 1743-4022 trout/mile in stations 572’, 555’ and 530’ (Figure 3, Tables 6,7,8,9).

Angler Harvest Restriction Changes:

The substantial and consistent declines in wild trout throughout the lower Dog River prompted the implementation of a Test Waters Designation (V.S.A. Title 10, Chapter 103, Section 4142) requiring more restrictive harvest limits was implemented with the 2010 trout fishing season and applied to the entire 8.1 mile reach of the Dog River from the top of the Northfield Falls dam the downstream to the Junction Road Bridge in Berlin/Montpelier as follows:

Daily Limit: 0, all fish must be released immediately
Gear: Artificial flies and lures only
Time Period: April 10, 2010 – October 31, 2015

The catch and release or “no-kill” regulation is intended to minimize fishing related mortality (harvest, hooking mortality) in an attempt to stabilize or bolster wild trout population densities. The restriction of fishing to the use of artificial flies and lures is based upon extensive studies which have shown that trout caught with natural baits have a substantially higher mortality rate after being released (Taylor and White 1992, Wydoski 1977).

Following implementation of the Test Waters Designation, a group of anglers raised concerns regarding the potential impact on the ability of small children to participate in fishing with the exclusion of natural baits. Information from season long angler creel surveys on the lower Dog River during the 1991, 1999 and 2000 fishing seasons was used to address this concern. These surveys consisted of angler counts and interviews conducted every weekend day, holiday and on at least two weekdays per week. Information on angler demographics, tackle, fishing time, and fish caught or released was collected from more than 2,000 individual anglers during these 3 years.

The results showed that while children (<15 years old) accounted for 10.7% of the anglers interviewed, they only accounted for 8.5% of the fishing effort and less than 2% of the trout caught. This information suggests that allowing children to fish on the Dog River with bait would have a negligible impact on trout populations and therefore the Test Waters Designation was further modified to:

Daily Limit: 0, all fish must be released immediately
Gear:

- For anglers 15 years of age and older, fishing may only be done with artificial flies and lures.
- For anglers 14 years of age and under, natural baits may also be used

Time Period: April 10, 2010 – October 31, 2015

This Test Waters Designation period was further extended in 2015 to end on Dec 31, 2018.

2010-2015

In 2010, the first year of the catch and release restrictions, wild trout population levels rebounded in all four stations (Figure 4, Tables 6,7,8,9). Wild trout >6" levels in 2010 were the highest recorded since 2001 for stations 555' and 530'; the highest recorded since 2002 for station 572'; and the highest ever recorded for station 515'.

On May 27, 2011 the highest recorded discharge in the Dog River since 1989 was recorded at 7,640 cubic feet per second (cfs; Figure 5). Later that year, the remnants of T.S. Irene deposited over seven inches of rain in parts of the Dog River watershed on August 27 and 28, 2011 (Kirn 2012) resulting in the highest recorded flow on the Dog River since US Geological Survey (USGS) records were initiated in 1934 (Figure 5). This flow of 22,200 cfs more than doubled the maximum flow recorded during the 1973 flood (10,600 cfs) and resulted in substantial changes to channel and habitat characteristics throughout the lower river.

High, turbid flows and restricted access due to road, culvert and bridge closures precluded annual surveys of the lower Dog River in 2011. Due to changes in channel dimensions and character discussed earlier, stations 572' and 530' were the only stations consistently sampled from 2010-2015. Wild trout >6" dropped to a low of less than 100 trout/mile in both stations in 2013, but have slowly improved to near levels observed in 2010 (Figure 6). Rainbow trout YOY production remained strong in station 572', averaging over 3400 trout/mile from 2010-2015 (Figure 7, Table 6), while station 530' averaged 802 trout/mile (Table 8).

Stream Temperature:

Station 572' maintained the coldest water temperatures of the four lower Dog River stations, exceeding 75°F for only one day over 10 years of sampling (Table 10). Maximum temperatures ranged from 68.9°F to 76.2°F. Stations 555' and 530' were intermediate among the four stations, with temperatures exceeding 75°F on 17 days over 8 years and 7 days over 11 years, respectively. Maximum temperature ranged from 71.0 to79.6°F in station 555' and 71.0 to 77.6 in station 530'. Station 515' was the warmest station with 69 days exceeding 75°F over 12 years of sampling. Twenty-one of those days were recorded in 2001, the 5th driest year recorded since 1895 in Vermont (UVM 2002). During 2001 this station recorded its highest maximum temperature of 82.7°F. As in the upper river, no clear trends in temperature metrics were evident over the sampling period.

DISCUSSION

The Dog River, considered one of Vermont's most productive wild trout streams, experienced significant declines beginning in the early 2000's within its lower reaches. While natural reproduction remained relatively strong, yearling and older trout declined to less than 25% of their abundance during the previous decade. Despite an abundance of sampling over the past 25 years, the cause of this decline is unclear and occurred despite the implementation of more restrictive harvest regulations since 2001. A nearly complete loss of rainbow trout in the upper Dog River and its tributaries, coincident with the lower river declines, suggest that broad environmental factors are the likely cause. Several environmental variables are briefly discussed below:

Temperature - Stream temperature has a profound effect on the distribution and abundance of wild trout populations. Extensive temperature monitoring throughout the Dog River presented in this report revealed temperatures within an acceptable range for wild rainbow trout and brown trout, with no indication of an increasing trend in temperature regimes.

Disease/Fish Health - There are several diseases which could conceivably impact wild trout populations. In 1998 and again in 2003, following the initial wild trout decline, a sample of wild rainbow trout were sampled for a variety of salmonid pathogens including IPN, VHS, BKD, IHN, enteric redmouth disease, furunculosis and whirling disease. All test results were negative. In addition a basic necropsy was conducted and indicated normal internal conditions.

Water Chemistry – In the early 1990's observation of increases aquatic macrophytes in the Dog River prompted investigations by the Vermont Department of Environmental Conservation (VDEC). A 1993 survey indicated dramatic changes in the algae community below the Northfield Waste Water Treatment Facility (WWTF) and indicated total phosphorous levels below the plant were 200 times background levels above the plant. A report of additional investigations in 1994-1995 concluded the Northfield WWTF impacted periphyton and macroinvertebrates through nutrient enrichment and toxicity (VDEC 1996). It should be noted that during this period, wild trout population abundance was consistently high. Nutrient enrichment may lead to increased abundance of macroinvertebrates and may have a positive influence on trout abundance (Stockner et al. 2000).

A 2001-2002 water quality and macroinvertebrate study and comparison of the Dog River, Batten Kill, Castleton River, Poultney River and Mettawee River continued to observe the effects of nutrient enrichment associated with the Northfield WWTF discharges (VDEC 2003). The decline of wild trout in the early 2000's during a period of continued nutrient enrichment suggests that this factor was not the primary cause of the change at that time. It is conceivable that continued reductions of nutrient inputs from the Northfield WWTP, associated with more stringent state and federal requirements, may reduce overall productivity of downstream reaches (Stockner et al. 2000).

Rainbow trout, which dominate the wild trout community in the lower Dog River, are sensitive to acidity which impacts reproductive success at low pH levels below 6.0 (Peterson et al. 1982). Water quality sampling in the Dog River in 2001-2002 revealed pH values ranging from 7.6 – 8.2 and alkalinity values ranging from 24.9 – 51.8 mg/l in five sampling stations. These results

and consistently strong rainbow trout yoy production throughout the study period does not suggest acidity is a problem in the lower Dog River.

Fish Kills – A complete fish kill of the Dog River occurred in 2004 from a chlorine discharge at the Northfield WWTF and continued downstream 0.62 miles to the confluence of Cox Brook (above Northfield Falls). While this event had a significant effect within the localized area of impact, the lower Dog River (below Northfield Falls) was unaffected due to the dilution provided by Cox Brook.

Physical Habitat – Trout require a variety of physical habitat features which vary with lifestage and environmental conditions. As successful reproduction and recruitment of yoy has been stable over the course of the study period, this discussion will focus on yearling and older trout physical habitat or "cover." Cover, in the form of large substrate, individual or complexes of large wood, roots systems, undercut streambanks, overhanging vegetation and in some instances man-made debris provide diverse and complex habitats which shelter fish from environmental conditions (e.g. high flows, ice) and predators (Bjorn and Reiser 1991). By creating visual separation, complex habitats are able to support higher densities of territorial salmonids (Hunter 1991). The Dog River contains a number of very large, deep and stable pool features which provide excellent habitat during a variety of environmental conditions. In between these large pools, secondary pools and cover associated with streambank and mid-channel features are important for supporting yearling and older trout.

There are many studies reporting increased trout abundance with improved cover conditions *where physical habitat was limiting the population.* In the Batten Kill, Cox (2011) reported a 2-5 fold increase in wild brook trout and brown trout abundance in pool habitats enhanced with complex habitat features. Likewise, the reduction of complex habitats following channel mining and channelization has been shown to have detrimental effects on macroinvertebrate and fish populations (Lau et al. 2006, Carline and Klosiewski 1985, Edwards, et. al 1984, Chapman and Knudsen 1980, Groen and Schmulbach 1978).

In 2001 VDFW conducted an assessment of cover within four electrofishing survey stations in the Dog River and repeated these protocols in 2010. Although obvious changes in habitat conditions were observed over this time period, the protocols were too coarse to discern these differences and provided little insight into habitat changes. Aerial photography has been valuable to document significant changes in channel planform over the past 20 years as shown in Figure 8. The lower Dog River has substantially increased its sinuosity in several locations where the river channel is not confined by public and private infrastructure. In some areas these changes have led to improved habitat conditions through scour and recruitment of large wood into the river channel. On the other hand, increased sediment loading from eroding streambanks and unstable habitat conditions have been observed.

Streamflow - Catastrophic flood events can also have profound effects on wild trout and other aquatic populations. Waters (1999) reported floods and sedimentation as the main environmental causes for the variation of wild brook trout populations in a long-term study of a Minnesota stream. Numerous studies have linked the abundance of age-0 trout to the timing and magnitude of flood events (Warren et. al. 2009, Carline and McCullough 2003, Seegrist and

Gard 1972). While young fish are often more susceptible to loss during flood events, high mortality of adult trout have been documented as well (Young et. al 2010, Carline and McCullough 2003).

The decline and subsequent recovery of fish populations following flood events are directly related to aquatic habitat quality and complexity. Pearsons et. al (1992) reported that following flooding, hydraulically complex reaches lost fewer fish and had higher species diversity than reaches with low complexity. Large floods will often result in large scale movement of stream substrates and may recruit large quantities of natural wood to stream channels resulting in changes in the size and depth of habitat features. Studies by Carline and McCullough (2003) and Dolloff et. al.(1994) indicate that while individual habitat units may have changed, overall habitat composition and complexity did not suffer and in some cases improved.

The period from 1990-1999 showed very moderate flow events in the Dog River (Figure 5). Annual maximum flows during this period averaged 2,851 cfs (maximum 4,430 cfs) with only 1 of 10 years exceeding 4,000 cfs (Q2 = 3100 cfs). The period from 2000-2015 was much more dynamic with annual maximum flows averaging 3,910 cfs (excluding T.S. Irene @ 22,200 cfs) while exceeding 4,000 cfs in 8 of 16 years and 5,500 cfs four times. While these observations are interesting, it is difficult to draw definitive conclusions due to the complex effect of streamflow event timing on wild trout populations, changes in habitat conditions and other confounding environmental variables.

Fishing Mortality – While the effects of broad environmental variables are difficult to influence, fishing mortality (harvest and hooking mortality) can be minimized with restrictive harvest and gear regulations. Vermont anglers are generally supportive of managing some streams as wild trout fisheries including the use of special fishing regulations (Connolly and Knuth 2010). A 2010 statewide angler survey indicated 77% of resident anglers supported the use of one or more special regulation strategy, although they were less supportive of catch and release (34%) and bait restrictions (29%).

While Vermont supports an abundance of wild trout streams, relatively few larger streams are capable of sustaining quality wild trout fisheries. *The Vermont Management Plan for Brook, Brown and Rainbow Trout* (VDFW 1993) places priority on managing for a diversity of trout fisheries while encouraging the use of harvest regulation and habitat protection/enhancement strategies to manage these resources.

CONCLUSION

While changes in water quality, physical habitat, streamflow and angler harvest have been observed during the study period, there is no clear evidence that these factors were solely responsible for the decline in wild trout abundance within the Dog River. It is more likely that a combination of these or other factors, largely out of our control, are responsible. Wild trout population increases in 2010 and again in 2015 are promising indications that the Dog River can continue to provide a quality wild trout fishery if managed conservatively. Minimizing fishing mortality through angler harvest and gear restrictions, while continuing to work with partner organizations and private landowners to protect and enhance aquatic and riparian habitats will be our most effective approach to maintain and improve this popular wild trout fishery.

RECOMMENDATIONS

1. Continue the existing Test Water Designation as a Fish and Wildlife Board regulation. The Fish and Wildlife Board process will provide the opportunity for anglers and other interested parties to provide input on the regulation proposal.

2. Continue to work with angler and watershed organizations, state and federal natural resource agencies, municipalities and private landowners to protect and enhance aquatic habitats and riparian areas in the Dog River watershed.

3. Advocate for protection and enhancement of aquatic and riparian habitats and aquatic organism passage within the Dog River watershed by actively participating in in environmental regulatory proceedings.

4. Continue to work with angler and watershed organizations, private landowners and municipalities to protect and enhance public access to the Dog River and its tributaries.

5. Continue to monitor wild trout populations in the Dog River and its tributaries.

6. Provide anglers with information on proper fishing and handling techniques to minimize mortality of released trout.

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LITERATURE CITED

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

Carle, F.L. and M.R. Strub 1978. A new method for estimating population size from removal data. Biometrics 34:621-630.

Carline, R.F. and S.P. Klosiewski. 1985. Responses to mitigation structures in two small channelized streams in Ohio. North American Journal of Fisheries Management 5:1-11.

Carline, R.F. and B.J McCullough. 2003. Effects of floods on brook trout populations in the Monongahela National Forest, West Virginia. Transactions of the American Fisheries Society 132:1014-1020.

Chapman, D.W. and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Transactions of the American Fisheries Society 109:357-363.

Claussen , J.H. 1971a. Job progress report. Vermont Fish and Game Department. Federal Aid in Fish Restoration, F-12-R-3&4, Job I-A, I-B. Montpelier.

Claussen , J.H. 1971b. Job progress report. Vermont Fish and Game Department. Federal Aid in Fish Restoration, F-12-R-3&4, Job I-C. Montpelier.

Claussen , J.H. 1972. Job progress report. Vermont Fish and Game Department. Federal Aid in Fish Restoration, F-12-R-5, Job I-B. Montpelier.

Connelly, N.A. and B.A. Knuth. 2010. 2010 Vermont Angler Survey Report. HDRU Series No. 10-3. Cornell University Human Dimensions Research Unit. Ithaca.

Dolloff, C.A., P.A. Flebbe and M.D. Owen. 1994. Fish habitat and fish population in a southern Appalachian watershed before and after Hurricane Hugo. Transactions of the American Fisheries Society 123:668-678.

Edwards, C.J., B.L. Griswold, R.A. Tubb, E.C. Weber and L.C. Woods. 1984. Mitigating effects of artificial riffle and pools on the fauna of a channelized warmwater stream. North American Journal of Fisheries Management 4:194-203.

Groen, C.L. and J.C. Schmulbach. 1978. The sport fishery of the unchannelized and channelized Missouri River. Transactions of the American Fisheries Society 107:412-418

Hunter, C. J. 1991. Better trout habitat. A guide to restoration and management. Montana Land Reliance. Island Press, Washington D.C.

Kirn, R. 1992. Creel survey: Mad, Winooski and Dog Rivers. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-25, Job I-2. Montpelier.

Kirn, R. 1996. MacMartin stream survey summary. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-30, Job I-1. Montpelier.

Kirn, R. 1998. Dog River trout evaluations. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-12-R-31. Montpelier.

Kirn, R. 2000. Dog River trout evaluations. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-3. Montpelier.

Kirn, R. 2000b. The potential use of specialized fishing regulations for improving wild trout stream fisheries in Vermont. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-2. Montpelier.

Kirn, R. 2012. Impacts to Stream Habitat and Wild Trout Populations in Vermont Following Tropical Storm Irene. Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R-14. Montpelier.

Lau, J.K, T.E. Lauer and M.L. Weinman. 2006. Impacts of channelization on stream habitats and associated fish assemblages in east central Indiana. The American Midland Naturalist 156:319-330.

MacMartin, J.M. 1959. Physical and chemical aspects of Poultney, Mettawee and Winooski Watersheds. Vermont Fish and Game Service. Federal Aid in Fish and Wildlife Restoration, F-2-R-7, Job 1, Montpelier.

MacMartin, J.M. 1960. Population studies - Winooski Below Montpelier & Lamoille River. Vermont Fish and Game Service. Federal Aid in Fish and Wildlife Restoration, F-2-R-8, Job 2, Montpelier

MacMartin, J.M. 1962. Statewide stream survey by watersheds. Vermont Fish and Game Department. Federal Aid in Fish Restoration, Final Report F-2-R, Montpelier.

Pearsons, T.D. and H.W. Li. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Transactions of the American Fisheries Society 121:427-436.

Peterson, R.H., P.G. Daye, G.L. Lacroix and E.T. Garside. 1982. *In* Acid Rain and Fisheries. Northeastern Division of the American Fisheries Society. Bethesda.

Reynolds, J.B. 1983. Electrofishing. *In* Nielsen, L.A. and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland.

Schill, D.J. 1996. Hooking mortality of bait-caught rainbow trout in an Idaho trout stream and a hatchery: implications for special regulation management. North American Journal of Fisheries Management 16:348-356.

Seegrist, D.W. and R.Gard. 1972. Effects of floods on trout in Sagehen Creek, California. Transactions of the American Fisheries Society 101:478-482.

University of Vermont. 2002. The 2001-2002 drought in Vermont. http://www.uvm.edu/~vtstclim/drought_vermont.html

Vermont Department of Environmental Conservation (VDEC). 1996. Bioassessment of the Dog River: 1994-1995. Biomonitoring and Aquatic Studies Section. Montpelier.

Vermont Department of Environmental Conservation (VDEC). 2003. A comparative assessment of the water quality and macroinvertebrate assemblage characteristics of the Batten Kill with several other wild trout streams in Vermont. Biomonitoring and Aquatic Studies Section. Montpelier.

Vermont Department of Fish and Wildlife (VDFW). 1993. The Vermont Management Plan for Brook, Brown and Rainbow Trout. Federal Aid in Fish Restoration, Project F-12. Montpelier.

Stockner, J.G, E. Rydin and P. Hyenstrand. 2000. Cultural oligitrophication: causes and consequences for fisheries resources. Fisheries 25(5) 7-14.

Taylor, M.T. and K.R. White. 1992. A meta-analysis of hooking mortality of nonanadromous trout. North American Journal of Fisheries Management 12:760-767.

Warren, D.R., A.G. Ernst and B.P. Baldigo. 2009. Influence of spring floods on year-class strength of fall- and spring-spawning salmonids in Catskill Mountain streams. 2009. Transactions of the American Fisheries Society 138:200-210.

Wydoski, R.S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management *in* A national symposium on catch and release fishing. Humbolt State University, Arcata, California.

Young, R.G. J.W. Hayes, J. Wilkinson and J. Hay. 2010. Movement and mortality of adult brown trout in the Motupiko River, New Zealand: effects of water temperature, flow and flooding. Transactions of the American Fisheries Society 1 39:137-146.

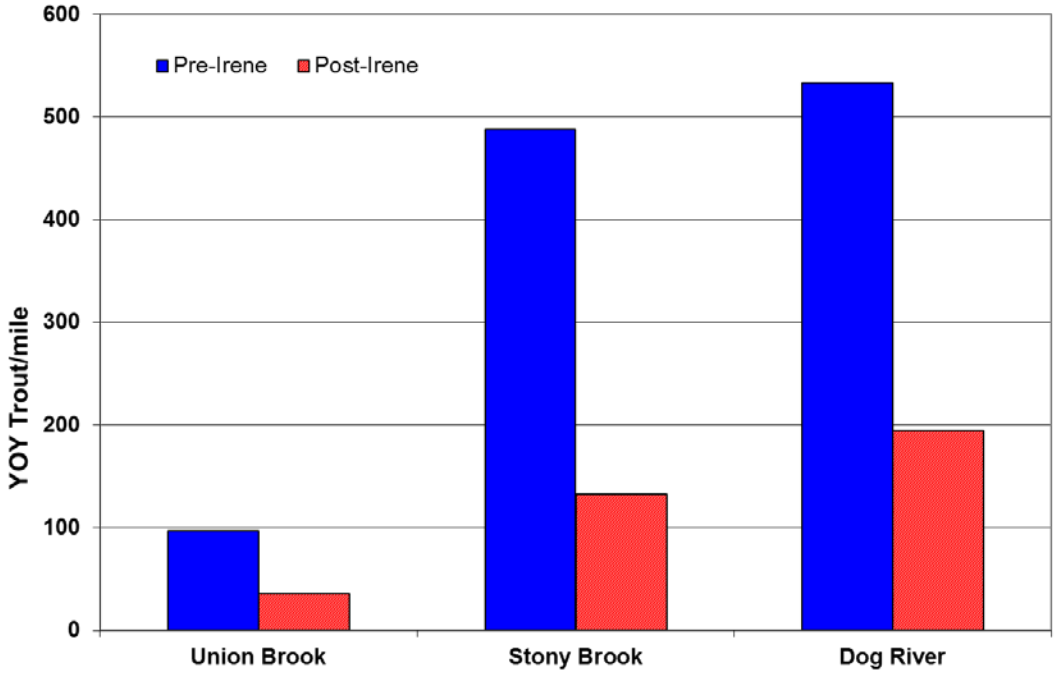

Figure 1. Young-of-year (YOY) trout population estimates (#/mile) in the Dog River and its tributaries before and after flooding from T.S. Irene; 2011.

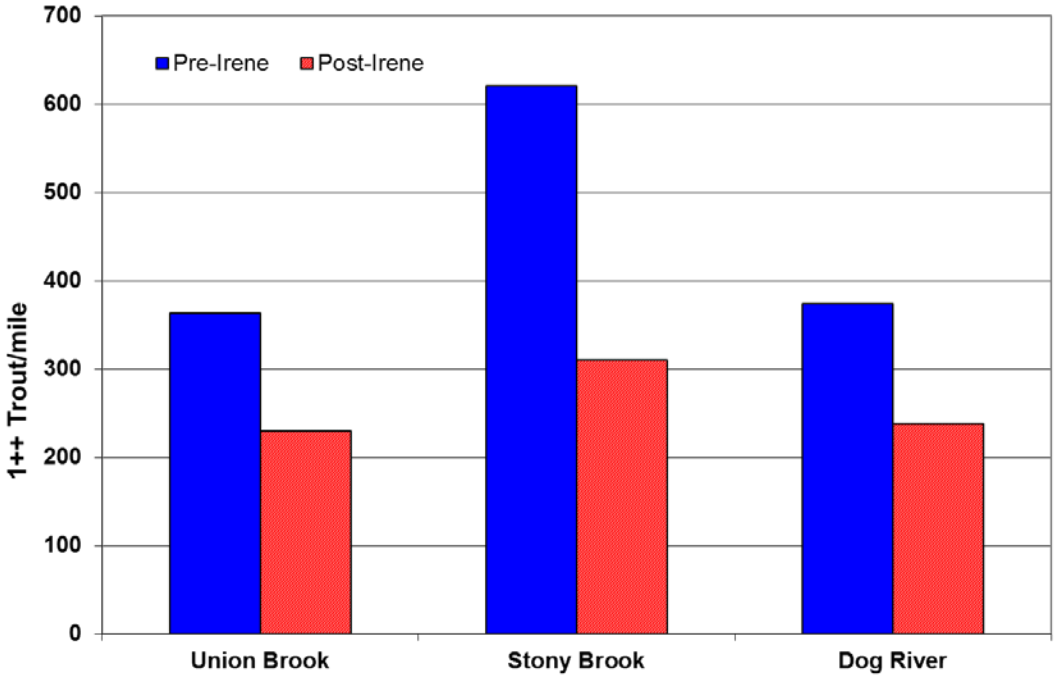

Figure 2. Yearling and older (1++) trout population estimates (#/mile) in the Dog River and its tributaries before and after flooding from T.S. Irene; 2011.

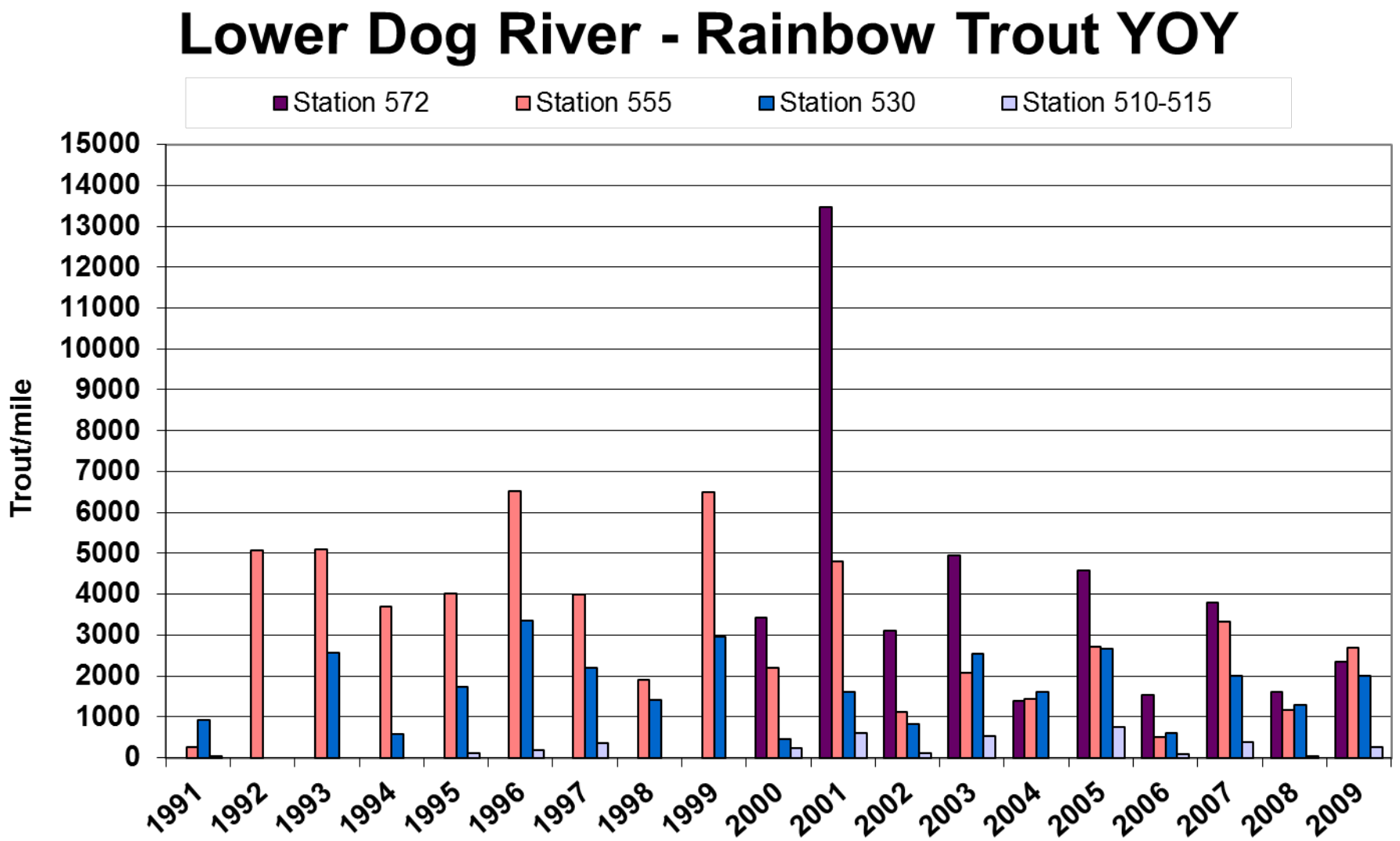

Figure 3. Rainbow trout young-of-year (YOY) population estimates (#/mile) from four stations within the lower Dog River; 1991-2009.

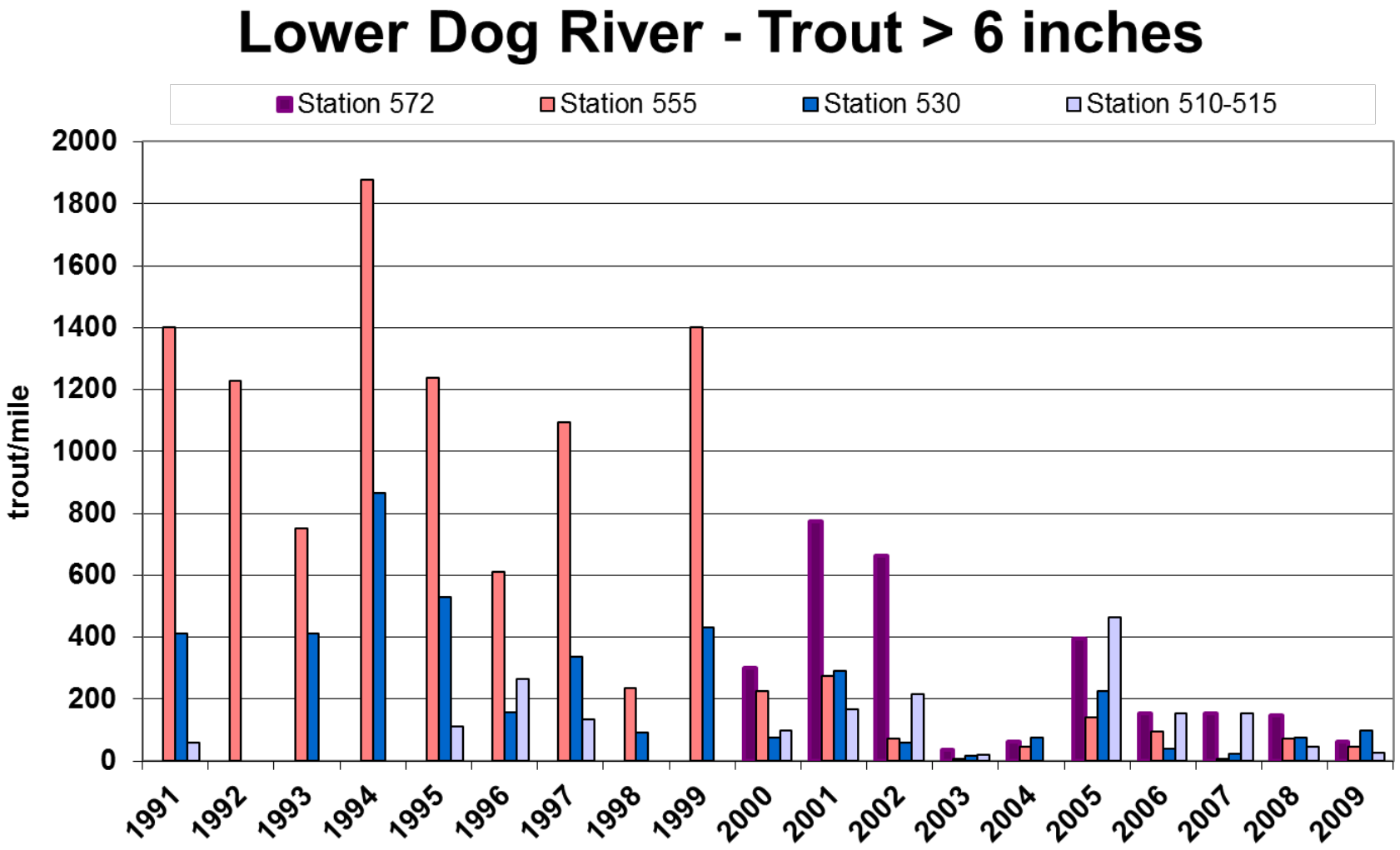

Figure 4. Rainbow trout yearling and older(1++) population estimates (#/mile) from four stations within the lower Dog River; 1991-2009.

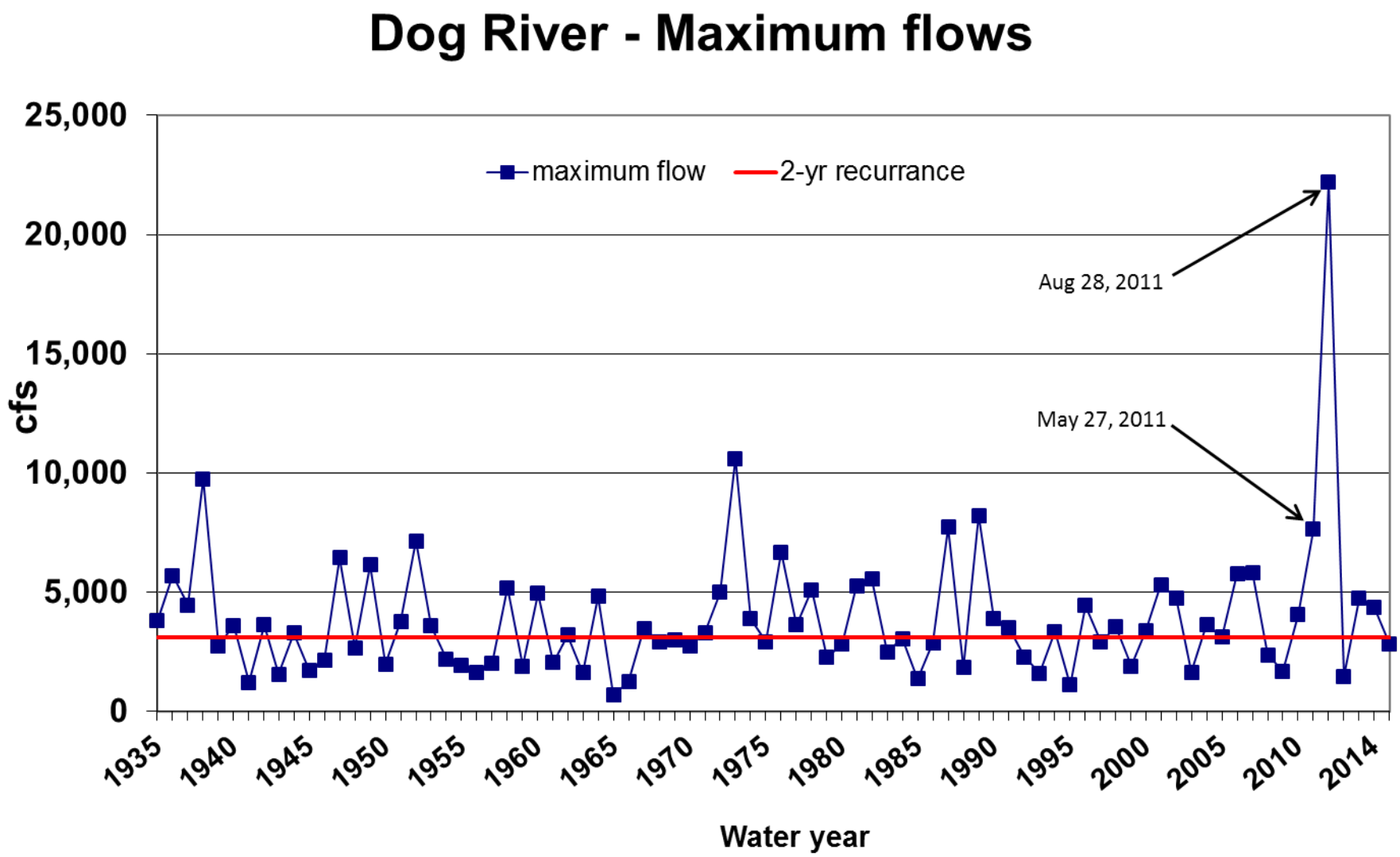

Figure 5. Maximum flows recorded on the Dog River for water years 1935-2015 by the US Geologic Survey.

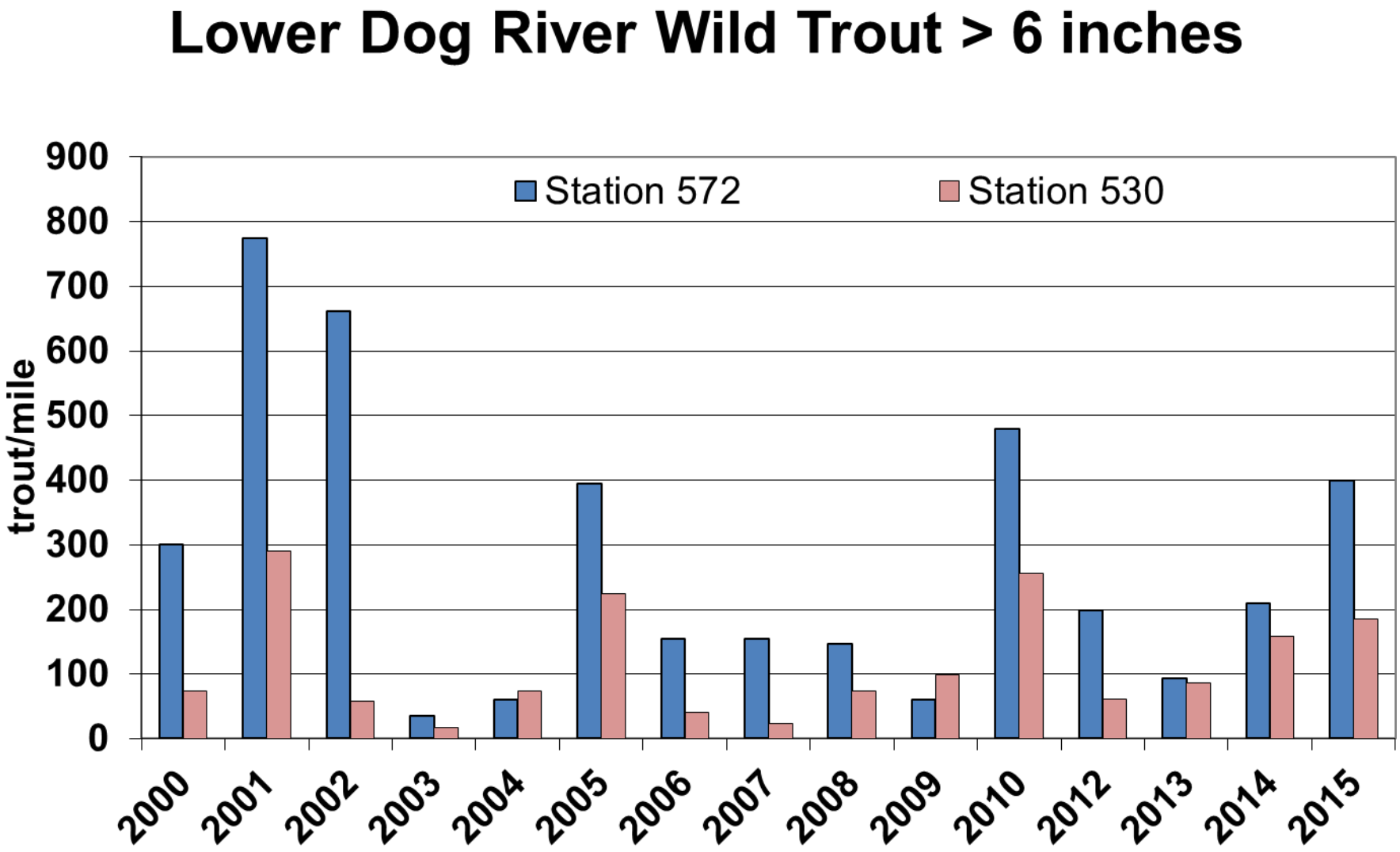

Figure 6. Wild trout (6 inches and greater) population estimates (#/mile) from two stations within the lower Dog River; 2000-2015.

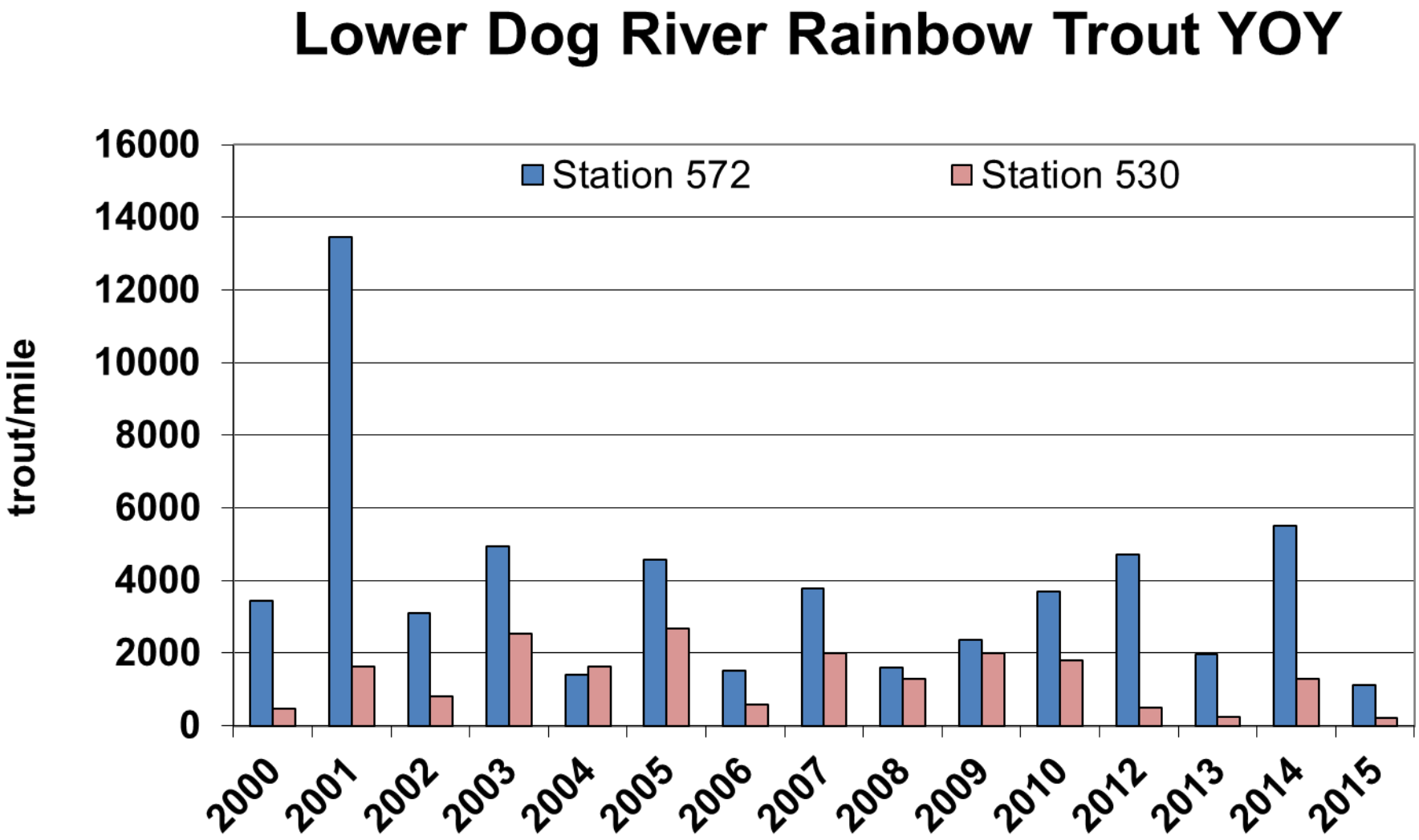

Figure 7. Rainbow trout young-of-year (YOY) population estimates (#/mile) from two stations within the lower Dog River; 2000-2015.

Figure 8. Arial photos of Dog River station 572 from 1996 and 2015 showing significant lateral migration and planform adjustments.

Table 1. Electrofishing survey summary for the Dog River and its tributaries; 2000-2015.

Stream	Elevation	Latitude	Longitude	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bull Run	1100	44.080314	-72.683761					X							X				
Bull Run	920	44.095831	-72.678764					X											
Bull Run	820	44.109453	-72.676614					X							X				
Chandler Rd Brk	630	44.192131	-72.644736					X											
Chandler Rd Brk	620	44.192078	-72.644236					X											
Chase Brook	610	44.207900	-72.638025					X			X		X	X	X	X	X	X	X
Chase Brook	580	44.206727	-72.636622												X	X	X	X	X
Cox Brook	790	44.188744	-72.673936					X											
Cox Brook	710	44.175722	-72.661631					X	X			X	X	X	X	X	X	X	X
Cox Brook	660	44.173242	-72.654669					X				X	X						
Felchner Brook	1060	44.125128	-72.715756																X
Felchner Brook	860	44.117411	-72.703872					X							X				
Stony Brook	1020	44.137519	-72.709025					X							X	X	X	X	X
Stony Brook	790	44.119219	-72.681664					X							X				
Robinson Brook	940	44.116064	-72.642978					X											
Sunny Brook	840	44.112183	-72.652097				X	X	X										
Sunny Brook	780	44.120875	-72.658308				X	X	X							X	X	X	X
Sunny Brook	760	44.122544	-72.661403				X												
Union Brook	835	44.157722	-72.677042					X							X	X	X	X	X
Unnamed Trib	540	44.229399	-72.615418								X								
Dog River	1340	44.105725	-72.752411				X				X				X	X	X	X	X
Dog River	870	44.117194	-72.710347				X	X											
Dog River	805	44.110350	-72.691261	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dog River	737	44.129106	-72.666708				X	X			X								
Dog River	725	44.141333	-72.666781					X	X										
Dog River	575	44.198439	-72.635747				X												
Dog River	572	44.199078	-72.634411	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Dog River	555	44.212308	-72.629089	X	X	X	X	X	X	X	X	X	X	X					X
Dog River	530	44.229003	-72.601261	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Dog River	517	44.237517	-72.596511				X										X	X	
Dog River	515	44.246156	-72.599111	X	X	X	X		X	X	X	X	X	X		X			

Table 2. Wild trout population estimates (#/mile; lbs/acre) from station 1340' on the Dog River; 1959-2015.

Elev 1340'	Brook Trout / mile				Brook Trout Lbs/acre
Year	YOY	<6 inches	6+ inches	Total	
1959	0	317	106	423	NW
1970	63	1837	63	1963	NW
1971	444	148	42	634	NW
1996	447	772	41	1260	30.7
1998	1484	171	29	1684	25.1
1999	2640	606	48	3294	35.5
2003	1163	121	73	1357	26.8
2007	646	223	45	914	19.9
2011	533	267	107	907	NW
2012	1895	43	64	2002	26.7
2013	192	1469	85	1746	59.2
2014	1150	468	64	1682	29.8
2015	2746	958	64	3768	45.3
Mean	***1031***	***569***	***64***	***1664***	**33.2**

NW = No weight measurements

Table 3. Wild trout population estimates (#/mile; lbs/acre) from station 805' on the Dog River; 1986-2015.

Elev 805'	Brook Trout / mile				Brown Trout / mile				Rainbow Trout / mile				Total Trout	
Year	YOY	<6	6+	Total	YOY	<6	6+	Total	YOY	<6	6+	Total	#/mile	Lbs/acre
1986	21	42	21	84	106	42	0	148	84	317	63	464	696	13.9
1991	25	12	62	99	37	12	37	86	262	474	150	886	1071	37.2
1995	594	0	69	663	304	55	55	414	705	55	69	829	1906	32
1996	78	147	39	264	147	49	39	235	39	108	59	206	705	16.3
1997	147	49	39	235	694	29	39	762	440	10	49	499	1496	17.1
1998	230	10	40	280	390	60	170	620	20	10	60	90	990	15.5
1999	640	30	130	800	90	130	50	270	300	0	40	340	1410	17
2000	390	330	150	870	280	0	20	300	0	90	100	190	1360	18.9
2001	160	120	90	370	20	90	10	120	30	0	20	50	540	9
2002	220	120	50	390	0	20	10	30	10	30	0	40	460	6
2003	660	30	90	780	150	0	0	150	70	0	60	130	1060	12
2004	330	30	110	470	220	0	30	250	160	0	20	180	900	10.1
2005	410	80	70	560	260	10	20	290	150	10	70	230	1080	11.1
2006	240	80	100	420	110	20	90	220	0	50	40	90	730	12
2007	190	10	50	250	50	0	30	80	0	0	0	0	330	5
2008	540	0	60	600	610	0	40	650	0	0	0	0	1250	8.8
2009	760	40	100	900	50	50	140	240	0	0	0	0	1140	14.4
2010	120	80	140	340	0	0	40	40	0	0	0	0	380	9.9
2012	908	116	21	1045	370	11	32	413	0	0	0	0	1458	11.2
2013	127	32	21	180	95	11	32	138	0	0	0	0	318	4.8
2014	472	12	12	496	1218	12	12	1242	0	0	0	0	1738	6.7
2015	410	124	62	596	273	174	124	571	0	0	0	0	1168	16.2
Mean	***349***	***68***	***69***	***465***	***249***	***35***	***46***	***330***	***103***	***52***	***36***	***192***	***1008***	***13.9***

Table 4. Stream temperature metrics (°F) for electrofishing stations in the upper Dog River; 2001-2015.

Elevation	Year	Days >65F	Days>72F	Days>75F	Days>80F	Max Temp F	7Day max AVG F	14 Day max AVG
1340	2012	8	0	0	0	66.6	65.2	64.3
1340	2014	2	0	0	0	65.9	62.6	62.1
1340	2015	4	0	0	0	65.9	64.3	63.3
805	2001	30	0	0	0	71.3	68.7	67.2
805	2003	29	0	0	0	68.3	67.0	66.8
805	2004	7	0	0	0	67.4	64.9	63.7
805	2005	29	0	0	0	67.4	66.4	65.9
805	2006	15	0	0	0	70.1	66.9	65.8
805	2007	7	0	0	0	66.2	64.7	64.1
805	2008	9	0	0	0	68.7	64.8	64.0
805	2012	46	0	0	0	69.8	68.1	67.1
805	2014	11	0	0	0	68.4	65.3	65.0
805	2015	20	0	0	0	68.3	66.6	65.3

Table 5. Wild trout population estimates (#/mile; lbs/acre) from tributaries of the upper Dog River; 1958-2015.

Stream / Elevation Year	Brook Trout / mile				Brown Trout / mile				Rainbow Trout / mile				Total Trout	
	YOY	<6	6+	Total	YOY	<6	6+	Total	YOY	<6	6+	Total	#/mile	Lbs/acre
Bull Run 1100														
1970	3675	1394	317	5386	0	0	42	42	190	84	84	358	5786	NW
1995	2352	600	96	3048	0	0	0	0	240	24	24	288	3336	40.7
2004	1886	773	19	2678	0	0	0	0	0	19	38	57	2735	34
2011	366	535	197	1098	0	0	0	0	0	14	0	14	1112	31.5
Bull Run 920														
1970	232	275	63	570	0	0	0	0	0	232	84	316	886	NW
1995	1729	223	74	2026	0	0	0	0	651	93	19	763	2789	18.3
2004	238	343	158	739	0	0	0	0	0	13	66	79	818	20.3
Bull Run 820														
1970	0	493	70	563	0	0	0	0	0	458	352	810	1373	NW
2004	172	80	40	292	929	0	13	942	570	13	27	610	1844	14.3
2011	238	158	79	475	0	0	13	13	0	13	0	13	501	11.6
Cox Brook 790														
1958	53	0	53	106	264	238	132	634	0	26	26	52	792	NW
1970	676	465	63	1204	0	422	63	485	0	0	0	0	1689	NW
2004	100	20	0	120	20	100	80	200	0	0	0	0	320	7.9
Cox Brook 710														
1970	0	42	42	84	253	211	253	717	0	253	422	675	1476	NW
1995	0	29	0	29	0	0	0	0	1620	145	203	1968	1997	21.7
2004	46	15	46	107	0	0	0	0	0	0	0	0	107	3.6
2005	726	0	26	752	0	0	13	13	370	0	79	449	1214	18.6
2008	304	0	119	423	0	0	0	0	0	0	0	0	423	10
2009	53	13	66	132	0	0	0	0	0	0	13	13	145	7.2
2010	106	40	66	212	0	0	0	0	330	0	0	330	542	5.5
2011	224	0	53	277	0	0	0	0	0	26	66	92	369	6.5
2012	660	0	66	726	0	0	0	0	502	0	26	528	1254	12.1
2013	488	92	79	659	0	0	0	0	0	26	40	66	725	11.4
2014	106	0	0	106	0	0	0	0	0	0	0	0	106	0.5
2015	1003	40	92	1135	0	0	0	0	0	0	13	13	1148	14.5

NW = No weight measurements

Table 5 (cont'd). Wild trout population estimates (#/mile; lbs/acre) from tributaries of the upper Dog River; 19598-2015.

Stream / Elevation Year	Brook Trout / mile				Brown Trout / mile				Rainbow Trout / mile				Total Trout	
	YOY	<6	6+	Total	YOY	<6	6+	Total	YOY	<6	6+	Total	#/mile	Lbs/acre
Cox Brook 660														
2004	111	14	83	208	0	0	14	14	514	0	28	542	764	9.7
2008	193	30	51	274	0	0	0	0	10	0	0	10	284	3.7
2009	386	0	41	427	0	0	0	0	0	0	0	0	427	3.2
Felchner Brook 1060														
1959	211	53	79	343	0	0	0	0	0	0	0	0	343	NW
1995	2539	1081	226	3846	0	0	0	0	0	0	0	0	3846	36.7
2015	74	987	99	1160	0	0	0	0	0	0	0	0	1160	28.7
Felchner Brook 860														
1995	1181	56	28	1265	56	0	0	56	931	0	0	931	2252	15.3
2004	618	150	134	902	50	17	0	67	0	0	0	0	969	21.1
2011	34	67	34	135	17	17	0	34	0	0	0	0	169	5.4
Robinson Brook 940														
1996	450	156	137	743	215	0	20	235	59	59	78	196	1174	33.6
2004	392	17	204	613	0	0	85	85	477	0	34	511	1209	41.1
Stony Brook 1020														
1959	169	0	0	169	0	0	0	0	0	570	63	633	802	NW
2004	254	568	150	972	0	0	0	0	0	0	15	15	987	20.6
2011	153	268	230	651	0	0	0	0	0	51	39	90	741	21.9
2012	2188	35	139	2362	0	0	0	0	0	0	52	52	2414	26.6
2013	226	469	261	956	0	0	0	0	0	0	0	0	956	23.2
2014	1750	15	119	1884	0	0	0	0	44	0	59	103	1987	24.8
2015	1171	909	174	2254	0	0	0	0	0	87	0	87	2341	26.7
Stony Brook 790														
1995	849	38	19	906	886	94	75	1055	1282	38	19	1339	3300	27.1
2004	611	262	247	1120	58	0	0	58	1164	204	102	1470	2648	48.2

NW = No weight measurements

Table 5 (cont'd). Wild trout population estimates (#/mile; lbs/acre) from tributaries of the upper Dog River; 1958-2015.

Stream / Elevation Year	Brook Trout / mile				Brown Trout / mile				Rainbow Trout / mile				Total Trout	
	YOY	<6	6+	Total	YOY	<6	6+	Total	YOY	<6	6+	Total	#/mile	Lbs/acre
Sunny Brook 860														
1986	40	0	10	50	966	60	239	1265	130	70	100	300	1615	46.4
1995	86	43	0	129	248	0	194	442	2403	22	97	2522	3093	47.3
2003	306	32	42	380	560	0	11	571	0	0	32	32	983	19.7
2004	137	11	21	169	739	11	116	866	253	0	11	264	1299	19.7
2005	137	42	63	242	517	0	138	655	63	11	117	191	1088	38.6
Sunny Brook 780														
1986	0	0	0	0	50	159	130	339	329	209	299	837	1176	34.3
1995	0	20	72	92	389	0	61	450	655	41	122	818	1360	30.5
2003	93	8	25	126	237	0	59	296	0	0	152	152	574	17.3
2004	19	0	95	114	917	10	153	1080	10	0	48	58	1252	24.7
2005	239	10	29	278	29	0	172	201	48	10	125	183	662	29.2
2012	41	0	41	82	1473	33	49	41	0	0	0	0	1678	40.9
2013	44	18	115	177	735	0	249	984	0	0	0	0	1161	39.3
2014	89	53	62	204	1063	0	89	1152	0	0	0	0	1356	21.1
2015	97	18	106	221	992	18	284	1293	0	0	0	0	1515	28.4
Union Brook 835														
1996	211	258	70	539	0	47	0	47	0	70	47	117	703	19.1
2004	674	455	255	1384	0	0	18	18	0	0	0	0	1402	33.2
2011	97	157	206	460	0	0	0	0	0	0	0	0	460	23.2
2012	1211	73	24	1308	0	0	0	0	0	0	0	0	1308	20
2013	36	1054	254	1344	0	0	24	24	0	0	0	0	1368	41.1
2014	521	48	206	775	0	0	0	0	0	0	0	0	775	22.9
2015	1708	145	206	2059	0	0	0	0	0	0	0	0	2059	26.5

NW = No weight measurements

Table 6. Wild trout population estimates (#/mile; lbs/acre) from station 572' on the lower Dog River; 2000-2015.

Elev 572'	Brown Trout / mile						Rainbow Trout / mile						Total Trout**	
Year	**YOY**	**<6**	**6-10**	**10-12**	**12+**	**Total**	**YOY**	**<6**	**6-10**	**10-12**	**12+**	**Total**	**#/mile**	**Lbs/acre**
2000	592	0	94	9	9	704	3434	9	94	34	60	3631	4438	60
2001	472	9	60	9	9	559	13470	215	618	69	9	14381	15026	92
2002	275	0	9	9	9	302	3099	69	618	17	0	3803	4131	51.2
2003	1202	9	0	0	0	1211	4954	9	17	9	9	4998	6209	22.7
2004	129	9	17	26	0	181	1399	0	9	9	0	1417	1607	13.6
2005	927	0	26	17	17	987	4585	34	300	17	17	4953	6035	47.7
2006	756	17	0	34	0	807	1528	17	86	9	26	1666	2568	30
2007	798	0	52	0	0	850	3786	9	60	26	17	3898	4817	25.5
2008	618	9	26	17	17	687	1614	17	69	17	0	1717	2421	26.2
2009	455	9	17	0	9	490	2352	9	26	0	9	2396	2903	16.2
2010	361	0	94	0	0	455	3700	69	343	17	26	4155	4636	38.5
2012	767	20	20	7	7	821	4716	33	118	26	20	4913	5806	39.2
2013	485	0	13	7	0	505	1955	33	66	0	7	2061	2566	13.3
2014	1640	0	46	0	7	1693	5510	26	131	13	13	5693	7419	30.8
2015	438	0	50	19	25	532	1132	269	300	0	6	1708	2277	39.5
Mean	***661***	***5***	***35***	***10***	***7***	***719***	***3816***	***55***	***190***	***18***	***15***	***4093***	***4857***	***36***

Table 7. Wild trout population estimates (#/mile; lbs/acre) from station 555' on the lower Dog River; 1991-2015.

Elev 555'	Brown Trout / mile						Rainbow Trout / mile						Total Trout**	
Year	YOY	<6	6-10	10-12	12+	Total	YOY	<6	6-10	10-12	12+	Total	#/mile	Lbs/acre
1991	352	47	133	0	23	555	258	368	1173	55	16	1870	2448	53.6
1992	798	63	117	0	16	994	5069	16	1040	39	16	6180	7190	84
1993	1197	0	149	8	0	1354	5100	55	532	47	16	5750	7112	46.7
1994	1377	23	266	0	8	1674	3692	242	1549	23	31	5537	7274	70.9
1995	1541	0	274	8	0	1823	4013	203	892	47	16	5171	7010	52.9
1996	415	0	55	8	0	478	6508	39	532	0	16	7095	7589	40.3
1997	1791	16	47	0	0	1854	3989	110	1009	23	16	5147	7009	51.1
1998	493	39	102	39	0	673	1893	8	78	8	8	1995	2668	22.4
1999	1392	0	156	102	16	1666	6485	8	1033	47	47	7620	9286	85.3
2000	375	0	8	8	8	399	2206	23	117	39	47	2432	2847	26.5
2001	594	0	70	0	0	664	4811	86	164	23	16	5100	5764	27.9
2002	133	0	16	0	0	149	1111	39	55	0	0	1205	1354	6.5
2003	1447	0	0	0	8	1455	2073	0	0	0	0	2073	3528	7.6
2004	454	0	8	8	0	470	1431	0	31	0	0	1932	1932	7.8
2005	1001	0	23	0	8	1032	2714	39	70	23	16	2862	3902	16.1
2006	508	0	16	0	8	532	493	55	47	0	23	618	1150	14.2
2007	1025	0	0	0	0	1025	3324	0	8	0	0	3332	4357	7
2008	172	8	63	0	0	243	1166	39	8	0	0	1213	1456	4.3
2009	446	8	31	0	0	485	2691	23	16	0	0	2730	3215	8.2
2010	641	0	55	0	0	696	3105	23	133	0	0	3261	3957	12.5
2015	180	12	37	6	12	248	311	68	99	0	12	491	739	15.2
Mean	***778***	***10***	***77***	***9***	***5***	***879***	***2973***	***69***	***409***	***18***	***14***	***3505***	***4371***	***31.5***

Table 8. Wild trout population estimates (#/mile; lbs/acre) from station 530' on the lower Dog River; 1991-2015.

Elev 530'	Brown Trout / mile						Rainbow Trout / mile						Total Trout**	
Year	YOY	<6	6-10	10-12	12+	Total	YOY	<6	6-10	10-12	12+	Total	#/mile	Lbs/acre
1991	396	0	165	8	17	586	932	17	198	8	17	1172	1775	25.3
1992	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1993	289	0	132	8	8	437	2558	8	239	8	17	2830	3267	30.9
1994	281	17	140	0	7	455	569	33	685	25	8	1320	1783	38.5
1995	503	0	116	17	0	636	1741	17	322	50	25	2155	2791	34.5
1996	157	0	8	8	0	173	3341	8	132	0	8	3489	3662	15.5
1997	520	25	41	0	0	586	2186	91	297	0	0	2574	3160	19.6
1998	272	0	17	25	8	322	1403	0	25	8	8	1444	1774	15
1999	792	0	66	25	0	883	2954	0	289	25	25	3293	4184	35.5
2000	206	8	0	0	8	222	462	8	41	8	17	536	766	9.9
2001	107	0	58	0	0	165	1617	33	165	17	50	1882	2047	28.3
2002	91	8	0	0	0	99	817	17	50	0	8	892	991	5.8
2003	429	0	0	0	0	429	2541	0	17	0	0	2558	2995	7.1
2004	256	0	8	0	8	272	1617	8	50	0	8	1683	1963	10.2
2005	652	0	25	33	0	710	2763	91	116	25	25	2930	3640	21.5
2006	272	0	8	0	0	280	594	33	33	0	0	660	948	5.3
2007	470	0	8	8	0	486	1997	0	8	0	0	2005	2491	5.6
2008	157	0	33	0	0	190	1295	74	41	0	0	1410	1600	6.5
2009	693	0	33	0	0	726	1997	41	66	0	0	2104	2846	10.6
2010	1114	0	50	8	0	1172	1790	33	173	8	17	2021	3193	18.6
2012	75	12	6	6	0	99	492	0	37	6	6	541	640	5.7
2013	56	0	19	0	6	81	230	37	62	0	0	329	410	4.9
2014	385	8	79	0	0	472	1289	16	71	0	8	1384	1856	6.8
2015	97	9	62	0	0	167	211	141	114	9	0	475	642	6.9
Mean	***360***	***4***	***47***	***7***	***3***	***419***	***1539***	***31***	***140***	***9***	***11***	***1726***	***2149***	***16.0***

Table 9. Wild trout population estimates (#/mile; lbs/acre) from station 515' on the lower Dog River; 2000-2015.

Elev 515'	Brown Trout / mile						Rainbow Trout / mile						Total Trout**	
Year	YOY	<6	6-10	10-12	12+	Total	YOY	<6	6-10	10-12	12+	Total	#/mile	Lbs/acre
1991	48	0	24	0	0	72	36	0	36	0	0	72	144	1.9
1992														
1993														
1994														
1995	37	0	9	0	0	46	120	0	65	19	19	223	269	8.4
1996	28	0	14	7	0	49	195	14	237	7	0	453	502	8.3
1997	111	18	18	0	6	153	357	18	111	0	0	486	639	8.5
1998														
1999														
2000	141	0	35	0	28	204	240	0	14	0	21	275	479	9.6
2001	7	0	29	0	7	43	603	14	101	7	22	747	797	9.7
2002	29	0	7	7	29	72	108	36	151	7	14	316	395	6.8
2003	323	7	0	0	0	330	524	0	14	0	7	545	875	2.8
2004														
2005	218	18	18	0	0	254	746	36	391	36	18	1227	1481	19.3
2006	100	0	46	18	9	173	82	0	73	9	0	164	337	9.6
2007	191	0	27	0	27	245	382	0	27	9	64	482	727	17.1
2008	27	0	18	0	0	45	46	0	27	0	0	73	118	1.2
2009	228	0	0	0	9	237	264	0	18	0	0	282	519	6.1
2010	337	0	64	0	0	401	291	18	364	9	36	718	1119	19.3
2012	266	0	7	0	15	288	369	0	44	44	15	472	767	11.1
Mean	***139***	***3***	***21***	***2***	***9***	***174***	***291***	***9***	***112***	***10***	***14***	***454***	***611***	***9.3***

Table 10. Stream temperature metrics (°F) for electrofishing stations in the lower Dog River; 2000-2015.

Elevation	Year	Days >65F	Days> 72F	Days> 75F	Days> 80F	Max Temp F	7Day max AVG F	14 Day max AVG
572	2000	40	0	0	0	68.9	67.4	66.6
572	2001	68	5	1	0	76.2	73.3	72.0
572	2002	56	5	0	0	73.1	72.0	70.2
572	2003	57	2	0	0	72.8	70.5	70.2
572	2005	72	2	0	0	72.5	71.3	71.0
572	2006	47	0	0	0	71.8	69.9	69.0
572	2008	57	9	0	0	74.5	72.1	71.4
572	2012	84	10	0	0	74.0	72.1	71.2
572	2014	66	1	0	0	72.8	69.5	69.4
572	2015	65	2	0	0	73.2	71.4	69.8
555	2001	80	28	9	0	79.6	76.7	75.5
555	2002	69	18	5	0	76.8	75.4	73.5
555	2003	74	9	1	0	75.1	73.0	72.6
555	2004	48	2	0	0	73.4	69.9	68.9
555	2005	86	16	1	0	75.2	73.6	72.8
555	2006	44	0	0	0	71.0	69.5	68.7
555	2007	71	6	0	0	74.5	71.6	69.9
555	2015	68	8	1	0	75.2	72.9	71.3
530	2000	48	0	0	0	71.0	69.3	68.3
530	2001	84	19	2	0	77.6	74.7	73.3
530	2002	41	0	0	0	70.7	70.0	68.7
530	2003	69	8	1	0	75.6	72.9	72.4
530	2004	62	5	0	0	74.7	71.6	70.2
530	2005	78	11	0	0	74.4	72.4	72.1
530	2006	55	0	0	0	71.6	70.5	69.7
530	2007	73	8	0	0	73.8	72.2	71.0
530	2012	91	31	4	0	76.3	74.0	72.7
530	2014	70	1	0	0	72.6	70.1	69.8
530	2015	76	10	0	0	74.9	73.5	71.9
515	2000	69	1	0	0	72.4	70.3	69.3
515	2001	101	39	21	2	82.7	79.0	77.5
515	2002	44	0	0	0	71.5	70.3	68.9
515	2003	91	23	9	0	79.0	76.6	76.0
515	2005	96	29	7	0	77.5	75.6	74.8
515	2006	65	3	0	0	72.4	71.0	70.2
515	2008	40	0	0	0	71.2	69.1	68.5
515	2011	66	15	4	0	77.4	74.5	72.9
515	2012	95	49	18	0	78.1	76.0	74.6
515	2014	80	14	1	0	75.9	72.6	72.0
515	2015	76	25	5	0	76.6	74.8	73.3