F-13-11

Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program

1999 Annual Report
to
PPL Montana
(formerly Montana Power Company)
Environmental Division
Butte

and

Turner Enterprises, Inc.
Gallatin Gateway

by
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April 2000

Montana Fish, Wildlife & Parks

EXECUTIVE SUMMARY

Two young-of-the-year Arctic grayling were captured in Ennis Reservoir in 1999. Populations of two year old & older rainbow trout in the Pine Butte, Snoball, and Varney monitoring sections remained at levels similar to recent years and remained high in the Norris section. Yearling rainbow trout numbers in the Pine Butte and Varney sections were measured at levels most recently seen in 1988. Two year old & older brown trout numbers increased markedly in the Pine Butte section and remained similar to recent years in other monitoring sections. Results of whirling disease tests conducted in the Madison River in 1999 document that water temperature at the time of egg hatching plays a crucial role in infection of young-of-the-year rainbow trout. Rainbow trout spawning and fry emergence was monitored in 1999. Water temperature was monitored at 14 sites throughout the Madison River, and air temperature at 7 sites. The Cherry Creek Native Fish Introduction Project was delayed due to an appeal of several permits necessary to conduct the project. The Federal Energy Regulatory Commission released the Final Environmental Impact Statement for the Madison-Missouri 2188 Project in 1999.

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INTRODUCTION

Montana Fish, Wildlife, & Parks (MFWP) has conducted fisheries studies in the Madison River Drainage since 1990 to assess and improve the status of the Arctic grayling (*Thymallus arcticus*) population of Ennis Reservoir, and to address effects of hydropower operations at Hebgen and Ennis dams on fisheries (Byorth and Shepard 1990, MFWP 1995, MFWP 1996, MFWP 1997a, MFWP 1998a, MFWP 1999). This work has been funded through an agreement with the Montana Power Company (MPC), owner and operator of the dams. In 1999 MPC sold its electrical generating system, including hydroelectric facilities, to Pennsylvania Power and Light (PPL). PPL formed a subsidiary called PPL Montana, which now owns and operates the facilities. The original agreement between MFWP and MPC was designed to anticipate relicensing requirements for MPC's hydropower system on the Madison and Missouri Rivers, which includes Hebgen and Ennis dams, as well as seven dams on the Missouri River (Figure 1). PPL Montana has maintained the course set by MPC, and convened several committees to address fisheries, wildlife, water quality, and recreation issues related to the operation of the hydropower facilities on the Madison and Missouri rivers. These committees are composed of representatives of PPL Montana and several agencies. The Madison Fisheries Technical Advisory Committee (TAC) is composed of personnel of PPL Montana, MFWP, the U.S. Fish & Wildlife Service (USFWS), the U.S. Forest Service (USFS), and the U.S. Bureau of Reclamation (BLM). Each entity has equal authority in decision making within the TAC. Collectively, the nine dams on the Madison and Missouri rivers are called the 2188 Project, which refers to the Federal Energy Regulatory Commission (FERC) license number that authorizes their operation.

Late in 1996, MFWP initiated a ten-year program entitled "The Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program". The goal of this effort is to conserve and restore the native westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the Madison River drainage. Fieldwork for this effort began in 1997 in tributaries of the Madison River. In June 1997, the USFWS received a petition to list the westslope cutthroat trout as a Threatened species throughout its entire range, which includes parts of Montana, Idaho, Oregon, Washington, and Wyoming. Six conservation/environmental organizations and one individual filed the petition.

In recognition of the severity of the situation faced by the westslope cutthroat trout, and in keeping with the philosophy of promoting native species on their lands, Turner Enterprises, Incorporated (TEI) offered access to the Cherry Creek drainage on the Flying D Ranch to assess its suitability for introducing westslope cutthroat. MFWP determined in 1997 that introducing westslope cutthroat to Cherry Creek is feasible, but would require the removal of all non-native trout presently in that portion of the drainage. MFWP and TEI subsequently entered into an agreement

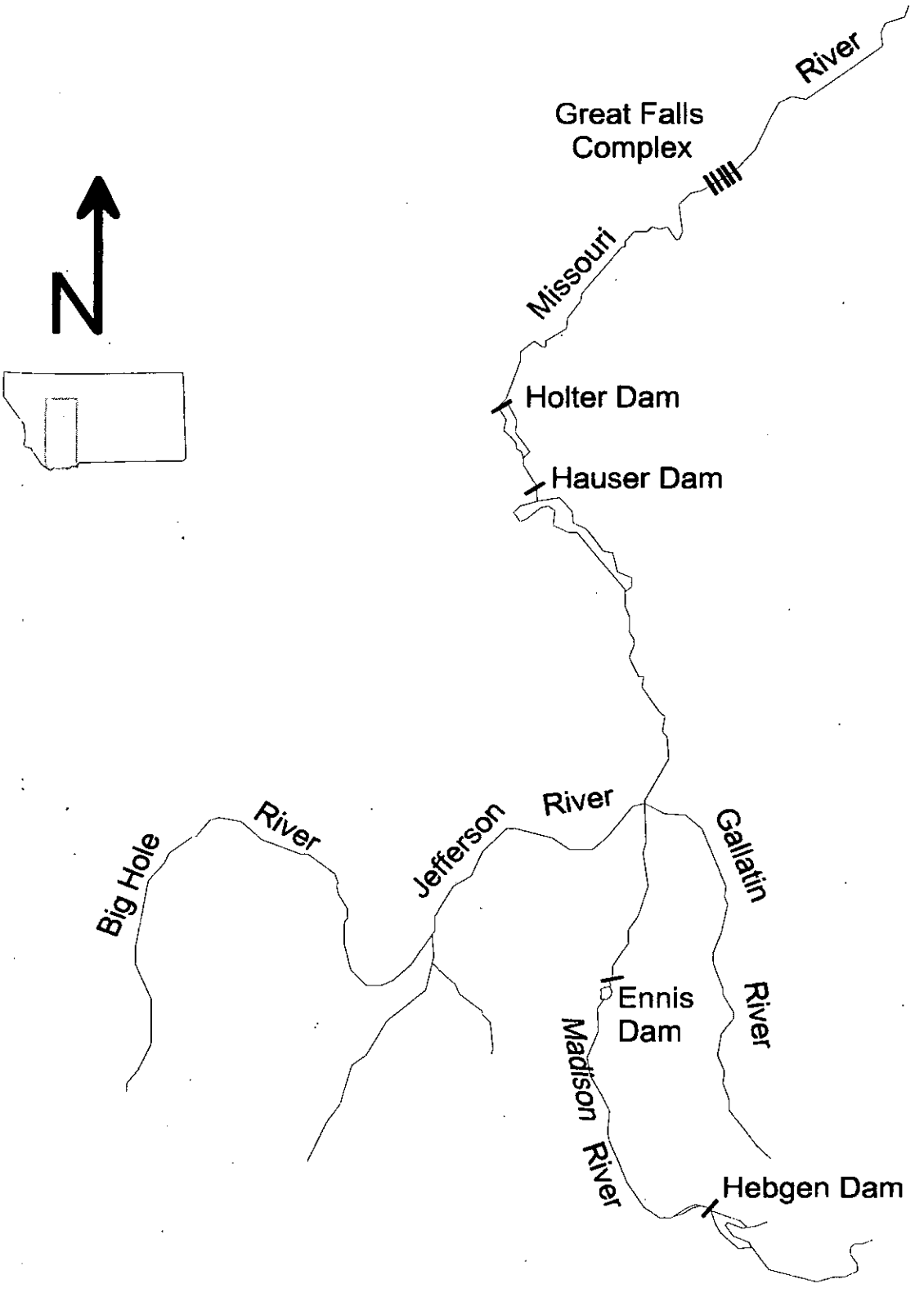

Figure 1. Locations of PPL Montana dams on the Madison and Missouri Rivers.

along with the Gallatin National Forest (GNF) to pursue this effort. The agreement outlines the roles and responsibilities of each party, including the GNF, which manages the public land at the upper end of the Cherry Creek drainage. TEI is contributing to the annual budget of the Madison Drainage Special Projects Program for the duration of the Cherry Creek Native Fish Introduction Project.

METHODS

Madison Grayling

Index sites in Ennis Reservoir (Figure 2) are sampled for young-of-the-year grayling and other fish species using a beach seine. A 125'x 5'x ¼" mesh seine with a 5'x 5'x 5' bag is fed off a moving boat in water up to five feet deep, with a worker in the water at each end of the seine. In 1999, contrary to past years, the seine was pulled parallel to the shoreline. This standard beach seining methodology was employed in 1999 due to the sparsity of macrophytes in Ennis Reservoir. The seine is pulled onto the shoreline and captured fish are enumerated by species.

In 1999, MFWP conducted a public participation process and produced an Environmental Assessment (MFWP 1999b) addressing the feasibility of introducing fluvial (river-dwelling) Arctic grayling in the Madison River between Quake Lake and Ennis Reservoir, and at the Missouri Headwaters area, including the lower Madison River from Greycliff to the Jefferson confluence. Several sources conducting whirling disease research have reported that grayling do not become infected with the *Myxobolus* parasite (Vincent pers.comm. 1998, Kaya pers.comm. 1998).

Gillnetting

Gillnets were used to sample adult fish in Ennis Reservoir in September 1999. Experimental nets, composed of five 25-foot panels of progressively larger mesh (¾", 1", 1 ¼", 1 ¾" 2") were set at four locations and left to fish overnight (Figure 2). For shoreline sets, the smallest mesh was set in the shallowest water, the largest mesh in the deepest water. Floating nets were used at the shallow south end of the reservoir, and one floating and one sinking net were used at the north end. Because the south end of the reservoir is so shallow, floating nets are capable of sampling the entire water column. At the deeper north end, a floating net and a sinking net were required to sample pelagic and benthic areas, respectively. Captured fish were removed from the nets, separated by species, measured, weighed, enumerated, and released.

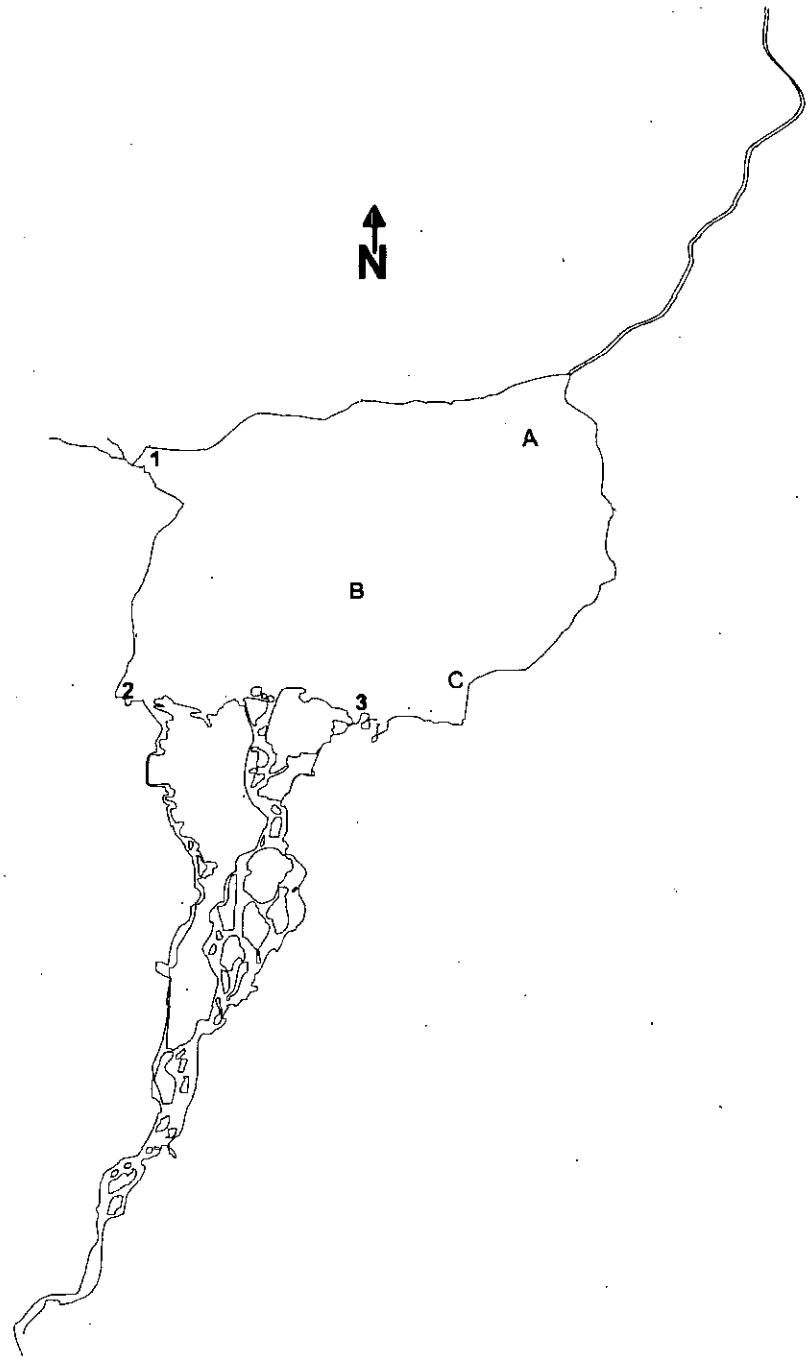

Figure 2. Locations of Ennis Reservoir seining and gillnetting sites. Numbers represent seining sites, letters represent gillnetting sites.

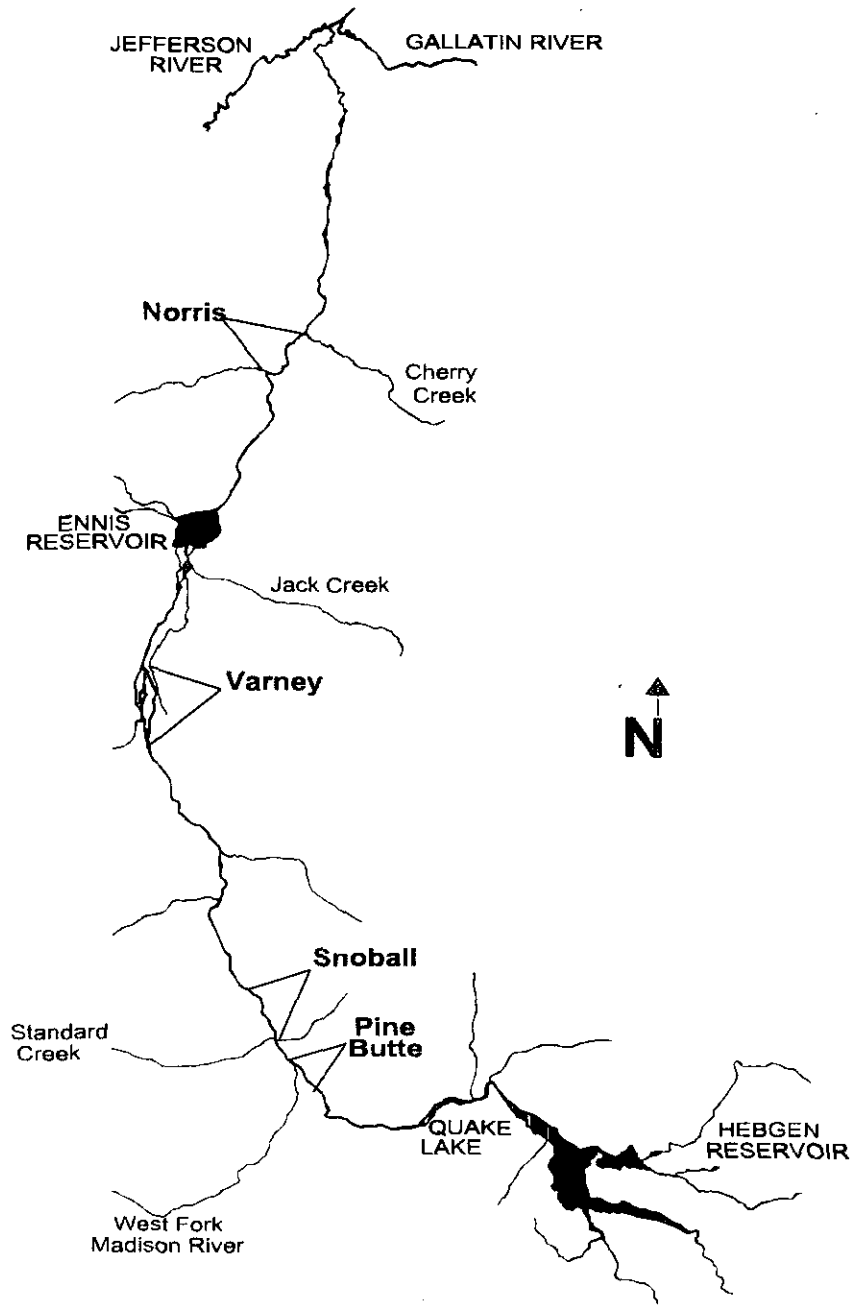

Figure 3. Locations of Montana Fish, Wildlife, & Parks 1999 Madison River population estimate sections.

Population Estimates

Electrofishing from a driftboat mounted.mobile anode system is the principle method used to capture Madison River trout for population estimates. Fish captured for population estimates are weighed and measured, marked with a fin clip, and released. A log-likelihood statistical analysis (Montana Fish, Wildlife, & Parks 1997b) is used to estimate trout populations in several sections of the Madison River (Figure 3). Yearling fish are distinguished from two year old & older fish. Generally, the number of two year old & older fish is a better indicator of year class strength and subsequent reproductive potential. Yearling numbers serve as an after-the-fact measure of the impact of whirling disease on reproductive success the previous year. Because 1999 aging is not complete, fish from 5.0 - 9.9 inches are used to estimate yearling abundance. The actual estimate may change after aging is completed.

Whirling Disease

Whirling disease (*Myxobolus cerebralis*) monitoring and research were continued in the Madison River in 1999 (Kerans et al. 1999). The sentinel fish live cage studies conducted in the Madison River in 1998 were repeated in 1999 using the same sites. Cages containing 60 young-of-the-year rainbow trout were placed at selected locations for multiple 10-day periods to conduct time-series and spatial-series studies. The time-series tests were conducted at the Kirby site from mid-April through mid-July and again from early September through late December. The spatial series was run twice, once in mid June, and once in mid September. The intent of using the same sites in 1998 and 1999 is to begin determining how infectious a particular site is year after year.

Nine rainbow trout spawning areas were tested for intensity of infection. Three of the sites were heavily used for spawning, three moderately used, and three lightly used. Paired sentinel live cages were placed at the upstream and downstream end of each site during each of two 10-day test periods. Each sentinel cage held 60 young-of-the-year rainbow trout. Water temperature and stream discharge was monitored during all tests at each site. At the end of each ten-day period, each lot of fish was transferred to whirling disease free water in a controlled setting, and maintained for 90 days. After 90 days, the fish were euthanized and examined for rate and severity of whirling disease infection. Invertebrate surveys were conducted monthly at each site to monitor tubificid numbers (Kerans et al. 1999, Krueger et al. 2000). Two hundred *Tubifex tubifex* were taken from each monitored spawning site to the Wild Trout Lab in Bozeman, held in individual containers, and observed for triactinomyxon (TAM) spore releases. Worms that released TAMs were sent to the Western Fisheries Research Center in Seattle for additional

testing to identify whether or not the TAMS released were *M.cerebralis*.

The Montana State University (MSU) Master of Science graduate program initiated in 1998, entitled "Spawning and Rearing Ecology of Madison River Rainbow Trout in Relation to Whirling Disease Infection Risk" was continued in 1999 (Downing and McMahon 2000). Through this program, the timing and location of rainbow trout spawning, fry emergence, and rearing is being studied to relate it to whirling disease infection risk. Forty-six redds constructed in 1999 were capped with traps made of cloth mesh netting to capture fry as they emerged from the gravel. A backpack-mounted electrofishing unit (shocker) is used to capture young-of-the-year rainbow trout to determine rearing locations and fry densities. MFWP and MSU personnel implanted 28 radio transmitters in mature rainbow trout throughout the Madison River between Quake Lake and Ennis Reservoir during September and October 1998. The transmittered fish were located weekly during the 1999 spawning season.

During the September 1999 electrofishing estimates, 36 adult brown trout in the Pine Butte, Snoball, and Varney sections were implanted with radio transmitters (Kerans et al. 1999). These fish were tracked on a weekly basis throughout the spawning season to assess spawning movements, location, and timing. Nine side channels between McAtee Bridge and Quake Lake dam and two side channels near Varney Bridge were selected as index sites to monitor spawning activity.

The whirling disease grade of severity scale has been modified, mostly for research purposes (Table 1). The only difference between this and the previous scale is that grade 4 infections have been further delineated, mostly for research purposes.

Temperature Monitoring

Water temperature was recorded at 14 sites and air temperature at seven sites throughout the course of the Madison River from above Hebgen Reservoir to the mouth of the Madison River at Headwaters State Park (Figure 4). Optic StowAway temperature loggers were programmed to record every 30 minutes, in Fahrenheit. Recorders deployed to monitor air temperatures were located in areas that were shaded 24 hours per day.

Biological and Biocontaminant Monitoring

As part of its relicensing effort, PPL Montana initiated a water quality monitoring program. In this program, personnel of PPL Montana and several agencies, including MFWP, conducted biological and biocontaminant monitoring collections at locations

Table 1. The MacConnell-Baldwin[1] whirling disease grade-of-severity scale and definitions. This scale is a modification of the previously reported scale (MFWP 1999). In the MacConnell-Baldwin scale, grades 1-3 remain unchanged, but grades 4 & 5 are further delineations of the previous grade 4 based on number and size of cartilage lesions and severity of inflammation.

Grade 0: No abnormalities noted. *Myxobolus cerebralis* is not seen.

Grade 1: Small, discrete, focus or foci of cartilage degeneration. No or few associated leukocytes.

Grade 2: Single, locally extensive focus or several smaller foci of cartilage degeneration and necrosis. Inflammation is localized; few to moderate numbers of leukocytes infiltrate or border lytic cartilage.

Grade 3: Multiple foci (usually 3 to 4[2]) of cartilage degeneration and necrosis. Moderate numbers of leukocytes are associated with lytic cartilage. Inflammatory cells extend minimally into surrounding tissues.

Grade 4: Multifocal (usually 4 or more sites[2]) to coalescing areas of cartilage necrosis. Moderate to large numbers of leukocytes border and/or infiltrate lytic cartilage. Locally extensive leukocyte infiltrates extend into surrounding tissues.

Grade 5: Multifocal (usually 6 or more[2]) to coalescing areas of cartilage necrosis. Moderate to large numbers of leukocytes border and/or infiltrate necrotic cartilage. The inflammatory response is extensive and leukocytes infiltrate deeply into surrounding tissues. This classification is characterized by loss of normal architecture and is reserved for the most severely affected fish.

[1]Grading scheme to quantify lesion severity developed by Beth MacConnell, USFWS/FWP pathologist & Tom Baldwin, veterinary pathologist, Washington Animal Disease *Diagnostic Laboratory. Grades are based on number and size of cartilage lesions and* severity of inflammation. All cartilaginous tissue in each section is examined. Best results are obtained when grade is based on two sections (or more) per fish (head or whole). In grades 1-5, intralesional stage(s) of *M. cerebralis* (vegetative - spore) are present.

[2]lesion numbers typical for head, not whole body sections.

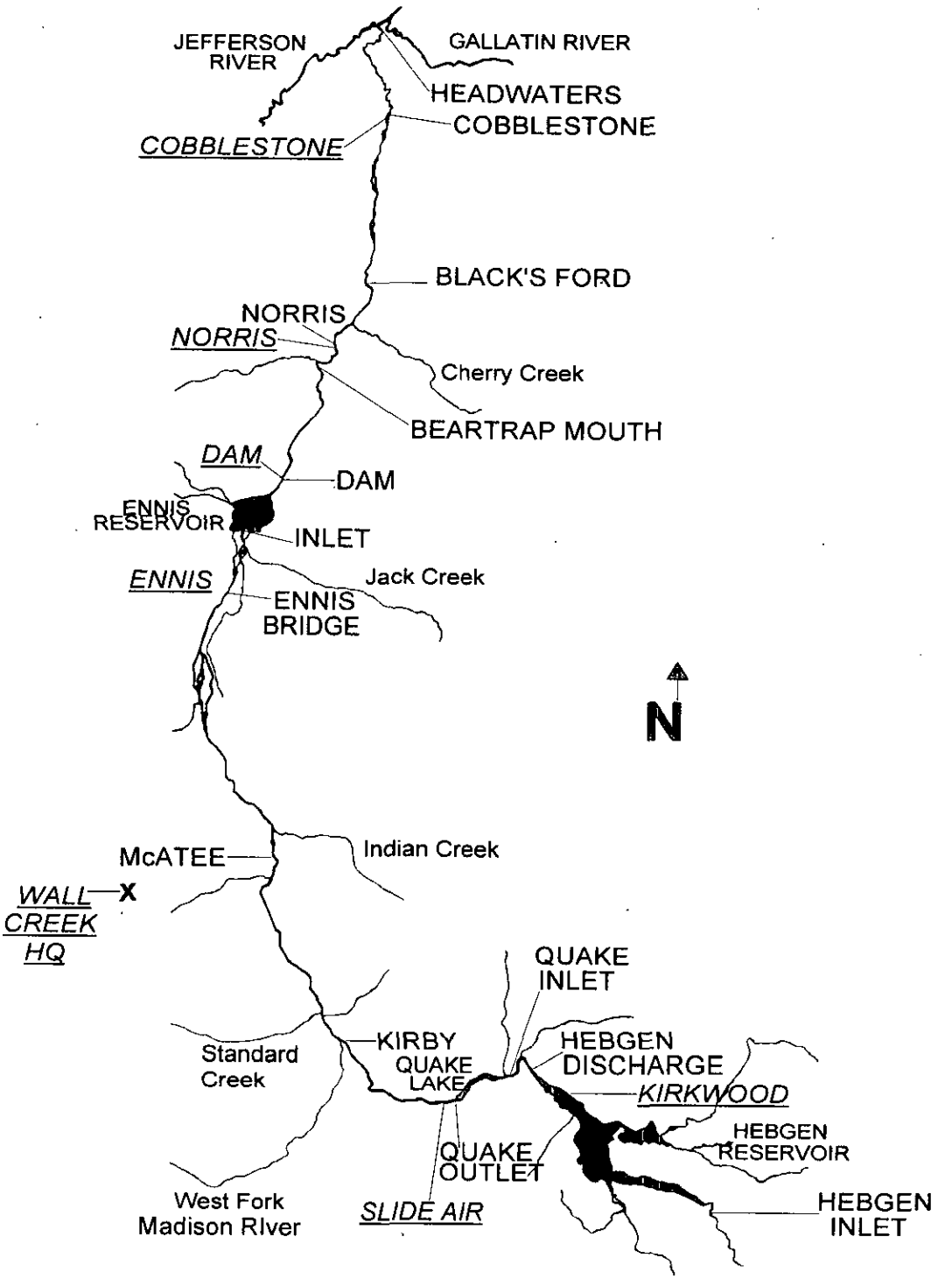

Figure 4. Locations of Montana Fish, Wildlife, & Parks 1999 temperature monitoring sites. Air temperature sites are underlined.

within the Madison/Missouri System. Aquatic invertebrate and periphyton samples were collected for biological trend monitoring and contaminant analyses at eight sites from the Madison River within Yellowstone National Park (YNP) to the Missouri River below Morony Dam at Great Falls. Samples were analyzed by a variety of consultants, and results reported to the PPL Montana Environmental Division.

Westslope Cutthroat Trout Conservation and Restoration

An MSU Master of Science graduate program was initiated in eastside Madison River tributaries between Ennis Reservoir and Quake Lake in 1998 (Shepard et al. In prep). This project, entitled "Madison Drainage Westslope Cutthroat Trout Survey", is assisting with data collection for the Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program.

The Cherry Creek Native Fish Introduction Project was scheduled to begin in August 1999, after being postponed in 1998. All required permits and approvals were renewed or newly applied for in 1999.

RESULTS AND DISCUSSION

Madison Grayling

Beach seining in Ennis Reservoir was conducted in September. Two young-of-the-year grayling and 34 young-of-the-year whitefish were captured. Young-of-the-year white sucker (*Catostomus commersoni*) were also captured, but not enumerated. Site descriptions, dates, and catches are listed in Appendix A.

Some anglers and fishing guides reported catching adult grayling in the Madison River between Ennis and McAtee Bridge during the 1999 fishing season. Less than 10 grayling were reported.

MFWP issued a Decision Notice (MFWP 1999c) approving the introduction of fluvial grayling at three sites - the lower Beaverhead River, the Missouri River Headwaters area, and the upper Madison River. This Decision Notice modified the original proposal to delay upper Madison River introductions until 2001 or later to allow on-going whirling disease, wild trout, and native species management options to be analyzed. A final decision on the upper Madison introduction will be predicated upon synthesis of these efforts.

Gillnetting

Results of 1999 gillnetting are presented in Table 2. As in previous years, few rainbow or brown trout and no grayling were captured.

Table 2. Summary of September 1999 gillnet catch in Ennis Reservoir. Length is in inches, weight is in pounds.

	UC[1]	Wsu	LnSu	MWF	Rb	LL
Avg.length	10.6	13.7	13.4	11.9	14.4	14.9
Avg.weight	0.62	1.38	1.15	0.66	1.48	1.30
Number sampled	69	84	5	2	11	13

[1] UC = Utah Chub; Wsu = White Sucker; LnSu = Longnose sucker; MWF = mountain whitefish; Rb = rainbow trout; LL = brown trout

Population Estimates

Population estimates were conducted in the Norris section in March and in the Pine Butte, Snoball, and Varney sections in September (Figure 3). Estimates in all sections in 1999 are provisional until age samples are complete.

In the charts illustrating annual population trends, stacked bars represent yearling and age 2 & older classes, with the top of the combined bars depicting the total population. Because Norris estimates are conducted in March each year, yearling fish are too small to capture in adequate numbers to derive an estimate of their abundance.

Figures 5-8 illustrate historic population levels of rainbow trout per mile. Preliminarily, rainbow trout numbers increased in all sections in 1999 due to a strong yearling cohort. This yearling cohort, the result of the 1998 spawning year, is the largest since prior to the onset of whirling disease. Rainbow trout in the Norris section below Ennis Reservoir remain similar to levels seen in 1998 and 1990-93.

Brown trout numbers per mile are illustrated in Figures 9-12. In 1999, two-year-old and older brown trout increased in all

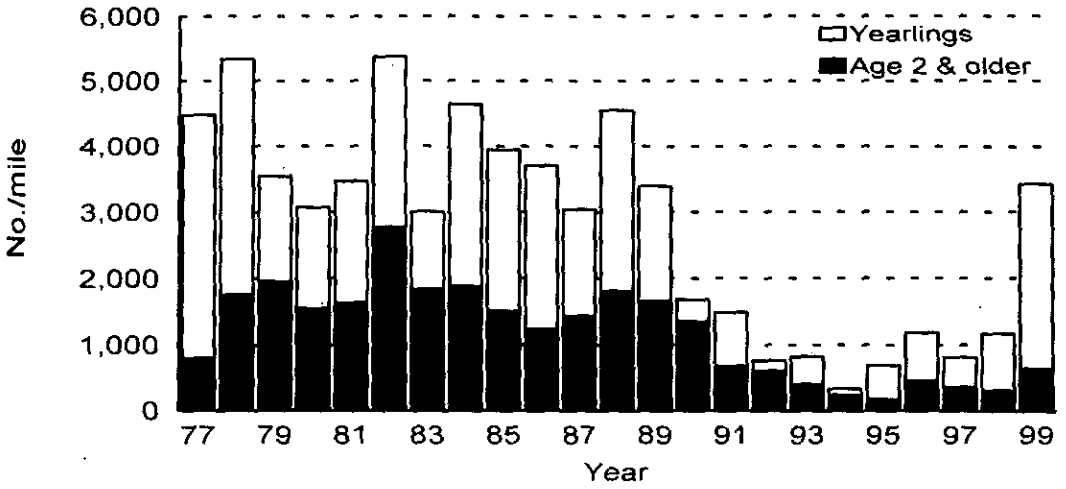

Figure 5. Rainbow trout populations in the Pine Butte section of the Madison River, 1977-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

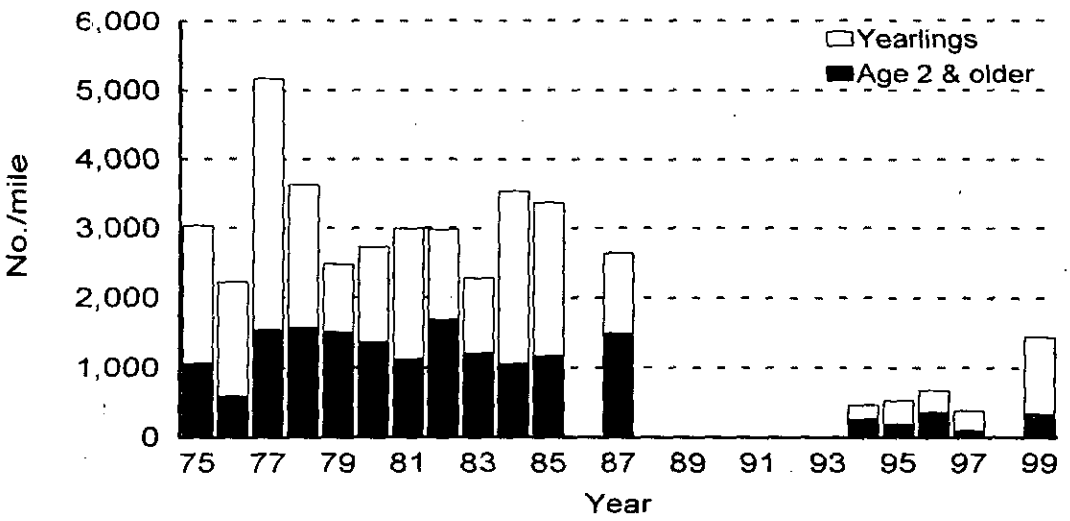

Figure 6. Rainbow trout populations in the Snoball section of the Madison River, 1975-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

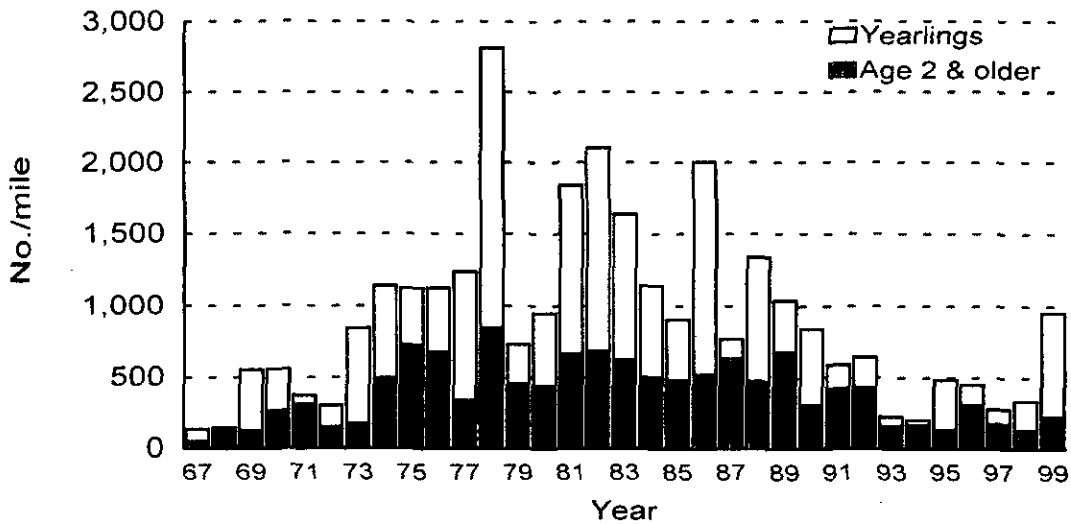

Figure 7. Rainbow trout populations in the Varney section of the Madison River, 1967-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

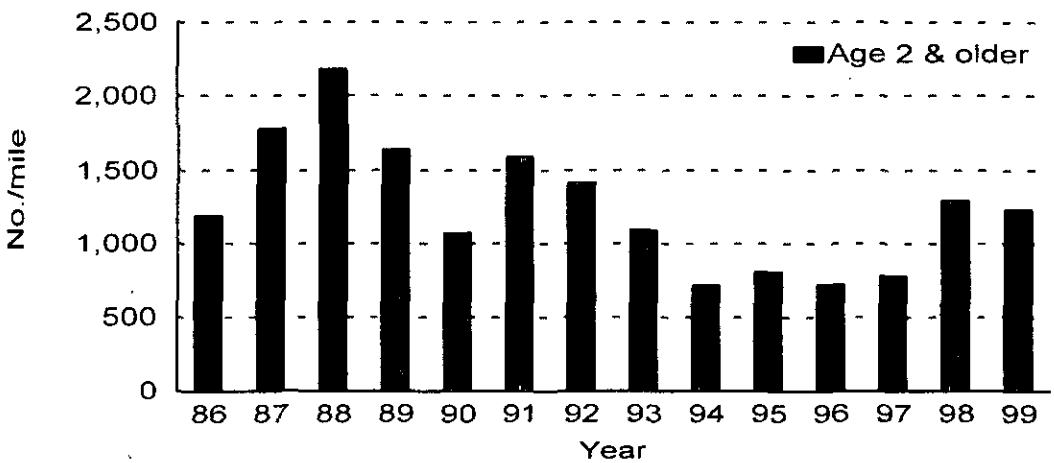

Figure 8. Rainbow trout populations in the Norris section of the Madison River, 1986-99, spring estimates.

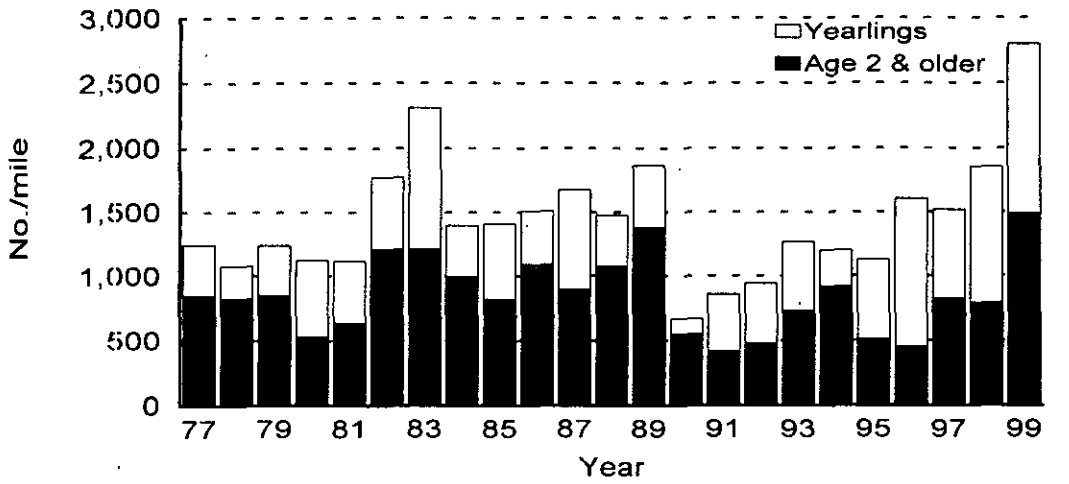

Figure 9. Brown trout populations in the Pine Butte section of the Madison River, 1977-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

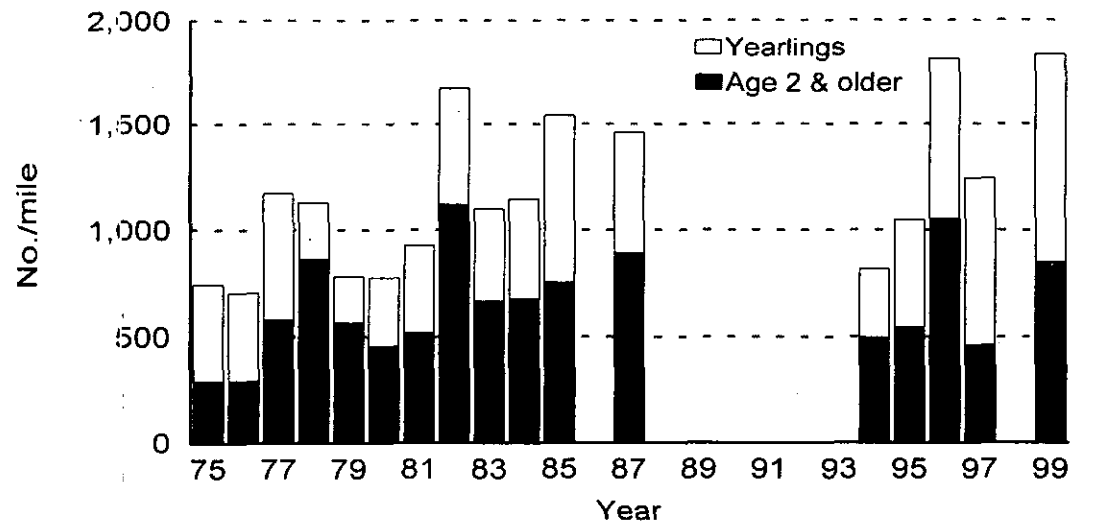

Figure 10. Brown trout populations in the Snoball section of the Madison River, 1975-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

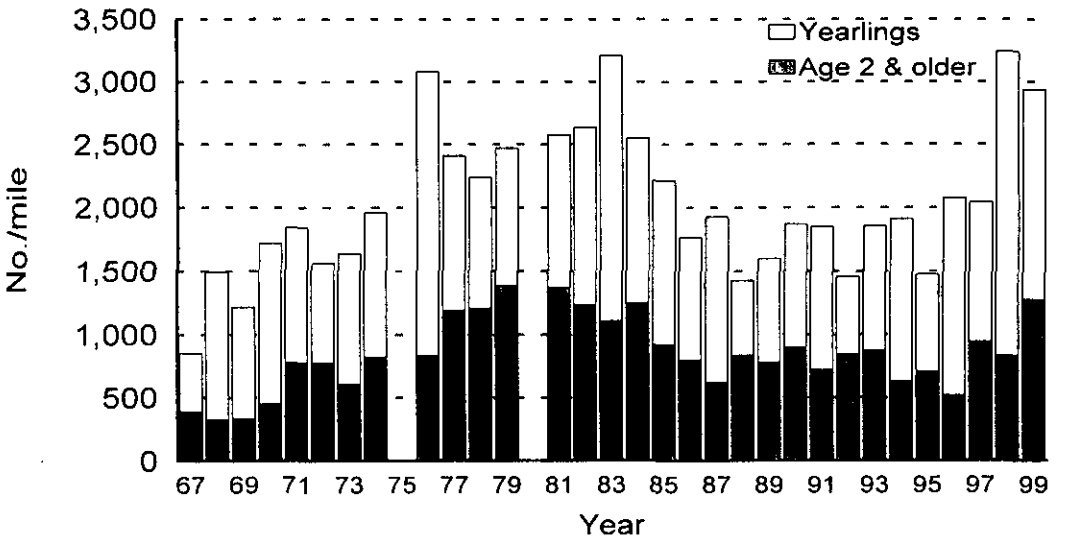

Figure 11. Brown trout populations in the Varney section of the Madison River, 1967-99, fall estimates. Data for 1999 is provisional pending completion of age samples.

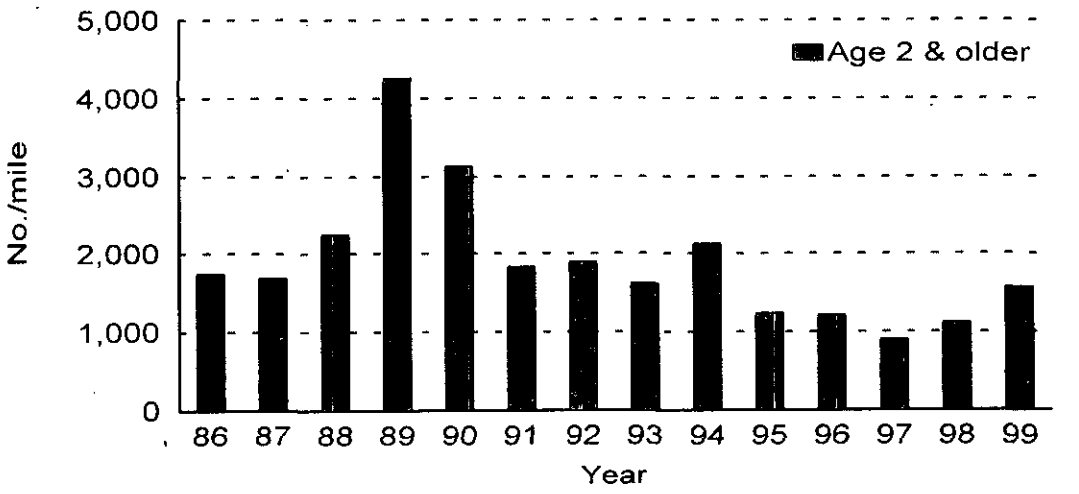

Figure 12. Brown trout populations in the Norris section of the Madison River, 1986-99, spring estimates.

sections, and yearling numbers remained strong.

Appendix B contains historic population levels of two year old & older rainbow and brown trout (± 80% C.I.) for each section.

Whirling Disease

Rainbow Trout

In the spatial series tests, Vincent (pers.comm. 2000) determined that the infection rate of sentinel YOY rainbows is not uniform throughout the length of the river, and that site-specific infection rates remained similar between 1998 and 1999. The time series tests at Kirby revealed that peak infection severity was similar both years, about 3.3-3.5, but peak infection occurred near the end of June in 1999 and in late May 1998. The strong 1998 cohort (yearlings in Figures 5-8) was likely a result of the unusually early production of TAMs, which occurred too early to infect hatching rainbow trout eggs. To date, 1998 is the only year that the timing of TAM production and hatching were sufficiently separated in time to allow production of a strong year class. Results of whirling disease tests in other Montana Rivers are available in Vincent (2000).

Results of the tests conducted at nine sites of varying rainbow spawning intensity to relate the affect of spawning intensity to whirling disease infection showed no correlation. To date, 36 of 38 worms exhibiting TAM release have tested positive for *M.cerebralis*.

In 1999, rainbow trout spawning was monitored from late February through early June (Downing and McMahon, in prep.). Spawning actually occurred from late March through early June with no obvious peak period. Most spawning occurred on a relatively consistent basis in April and May. Twenty-one of the 28 radio tagged fish were located during spawning, and exhibited two movement patterns. Seven fish either could not be relocated. Generally, all relocated fish showed upstream spawning movement of varying distances. Seventeen of the 21 fish spawned in the mainstem and four spawned in tributaries. The "average" mainstem spawning date was April 30, while the "average" tributary spawning date was May 27. A total of 875 redds were counted, with 649 above Raynolds Pass Bridge. Less effort was directed toward conducting redd counts below Raynolds Pass Bridge in 1999 than in 1998, which may partially account for 1999's higher proportion of redds above that point.

Fry emergence was monitored by placing redd caps over 46 redds in 1999 (Downing and McMahon, in prep.). Fry were captured from 31 of those redds. Emergence began in early June and ended in early August, with the peak occurring in late June and early July.

Brown Trout

Radio tagged brown trout displayed a wide variation in spawning movement, with no consistent pattern of upstream or downstream movement (Kerans et al. 1999). Spawning occurred throughout the river between the Quake Lake dam and Ennis Reservoir. Maximum movements documented were made by fish tagged in the Varney and Pine Butte sections, which moved 32 miles upstream and 35 miles downstream, respectively. Several fish moved into the West Fork to spawn. Only four of the tagged fish spawned in the Slide area below Quake Lake.

Spawning was first observed in late October with the peak occurring in mid-November. Redds were observed in the index side channels as well as other locations throughout the river between Quake Lake dam and Ennis Reservoir.

Temperature Monitoring

Optic StowAway temperature recorders were deployed throughout the Madison River to document air and water temperatures (Figure 4). Table 3 summarizes the data collected at each location in 1999, and Appendix C1 contains thermographs for each location. Appendix C2 contains thermographs at selected locations showing the 24-hour diurnal temperature fluctuation of each site around the warmest date of the year.

Biological and Biocontaminant Monitoring

Biological and biocontaminant monitoring was conducted at seven index sites established in previous years (3 Madison River sites & 4 Missouri River sites) (MFWP 1997a), and at an eighth site established at the Ennis Fishing Access Site. Analyses of 1999 collections have not been completed (Dan McGuire pers. comm. 2000). New Zealand Mud Snail (NZMS) (*Potomopyrgus antipodarum*) density remains high at the Yellowstone National Park (YNP) site (Table 4). A second NZMS monitoring site was established in YNP near highway 191 in 1997. The mean NZMS density at that site was 5668 and 17196 in 1997 and 1998, respectively. Relative abundance was 58 % in 1997 and 70 % in 1998. NZMS have been detected at the upper end of the Madison Arm of Hebgen Reservoir. NZMS have not been detected at any sites below Hebgen Reservoir.

Montana State University (MSU) researchers have sampled numerous sites in the Madison River in Yellowstone National Park(YNP) for New Zealand Mud Snails (NZMS) (*Potomopyrgus antipodarum*) since 1997 (B. Kerans, Wild Trout Lab, pers.comm. 2000). They use a 153 micron mesh sampling screen (1 micron = 1/1000th millimeter) which allows them to collect smaller NZMS than collected in the PPL

Table 3. Maximum and minimum temperatures (°F), the dates of each, the period monitored, and the number of recordings at selected locations in the Madison River drainage, 1999. Charts for each location are in Appendix C.

Site	Maximum	Minimum	Period	# readings
Water				
Hebgen inlet	73.26 (7/13)	44.21 (9/28)	4/24-10/6	7944
Hebgen discharge	65.42 (8/30,31)	38.16 (4/24,25)	4/24-10/6	7944
Quake Lake inlet	65.44 (7/29)	37.60 (4/24)	4/24-10/6	7944
Quake Lake outlet	63.78 (7/29)	37.96 (4/24-27)	4/24-10/6	7944
Kirby Bridge	68.70 (8/10)	36.49 (4/29)	4/24-10/6	7944
McAtee Bridge	69.76 (7/30)	34.71 (4/29)	4/24-10/6	7944
Ennis Bridge	71.22 (7/28,30)	36.70 (4/29)	4/24-10/6	7944
Ennis Reservoir Inlet	75.05 (7/28)	36.29 (4/30,5/1)	4/24-10/6	7944
Ennis Dam	70.71 (7/13,28, 31)	43.23 (4/30,5/1)	4/24-10/6	7944
Beartrap Mouth	75.26 (7/28,31 8/9)	42.37 (4/24)	4/24-10/6	7944
Norris	75.90 (7/28)	42.41 (4/24)	4/24-10/6	7944
Black's Ford	77.86 (7/28)	41.05 (4/24)	4/24-10/6	7944
Cobblestone	79.68 (7/27)	40.70 (4/24)	4/24-10/6	7944

Table 3, continued.

Headwaters S.P. (Madison mouth)	83.54 (7/28)	41.57 (4/29,10/3)	4/24-10/6	7944
Air				
Kirkwood Store	92.69 (7/28)	23.43 (♠)	4/24-10/6	7944
Slide	91.03 (7/13,23 27)	24.13 (5/6)	4/24-10/6	7944
Wall Creek HQ	94.98 (7/28)	23.51 (9/28,10/3)	4/24-10/6	7944
Ennis Fisheries Office	99.26 (8/26)	23.40 (♥)	4/24-10/6	7944
Ennis Dam	93.89 (7/28)	27.40 (5/6,10/3)	4/24-10/6	7944
Norris	87.60 (7/24)	28.37 (5/6)	4/24-10/6	7944
Cobblestone	87.87 (7/29)	23.52 (9/28, 10/3)	4/24-10/6	7944

♠ 5/5,6; 9/28; 10/3
♥ 4/24; 5/6; 9/28; 10/3

Montana monitoring program. They calculate NZMS densities ranged between 46,000 and 299,000/m² in 1997, decreased over winter to 20,000/m² in March 1998, but then increased to as high as 300,000/m² by July 1998 (Kerans et al.2000). Corresponding reductions in other invertebrate fauna, particularly mayfly species, is likely due to the overwhelming density of NZMS. National Park Service personnel have confirmed the presence of NZMS in the Firehole, Gardner, and Snake rivers in YNP (D. Mahoney, NPS, pers.comm. 1999).

Westslope Cutthroat Trout Conservation and Restoration

During 1999, personnel from Montana State University continued data collection for the Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program (Shepard et al. in prep). They surveyed all or parts of 14 streams on the west slope of the Madison Mountain Range, and found no westslope cutthroat trout. Several streams are potential sites for introduction of westslope cutthroat trout, and will be further

Table 4. Density (#/m^2) and relative abundance (percent of all organisms collected) of New Zealand Mud Snails, and mesh size (microns) of sampling screen used during biological monitoring to collect samples in the Madison River in Yellowstone National Park, September 1994, August 1995-99.

	Density	relative abundance	mesh size
1994	19	7	1700
1995	156	8	800
1996	2187	52	800
1997	7345	62	560
1998	7268	59	560
1999	not yet summarized		

evaluated for introduction potential.

The Cherry Creek Native Fish Introduction Project was scheduled to begin in August, but was delayed when a 60-day Notice of Intent to Sue naming the U.S. EPA, USFS, DEQ, and FWP was filed. DEQ conducted an EA on the human health aspects of the project, and concluded there is no human health threat. They issued the necessary permits for the project in October, but within minutes of issuing those permits, their decision was appealed by an industry attorney, the Public Lands Access Association, Friends of the Cherry Creek Cutthroat, and one other individual. This suspended the DEQ permits until the appeal is resolved, expected to be in May 2000.

CONCLUSIONS AND FUTURE PLANS

Beginning in 2000, PPL Montana and the agencies which compose the Madison River Fisheries TAC will begin designing and implementing fisheries mitigation, protection, and enhancement measures to meet the conditions of the 2188 license expected to be issued by FERC in 2000. A Memorandum of Understanding between PPL Montana and the agencies is being developed to guide this program for a period of ten years.

Four tasks will be initiated in 2000: 1) a year long creel census on Hebgen Reservoir; 2) determining the feasibility of re-watering selected eastside tributaries of the Madison River by improving irrigation efficiency and reducing the volume of water withdrawn from the streams; 3) participating in a study to determine local factors in concentrated spawning areas which may increase the severity of whirling disease infection in young-of-the-year fish produced in those areas; and 4) conducting radio

telemetry studies of fish in and below the Bypass Reach between Ennis Dam and Powerhouse to determine the importance of that reach for spawning.

The Hebgen creel will be conducted to determine the contribution of stocked rainbow trout to the angler creel, as well as other characteristics of the fishery. The ultimate goal will be to determine the need for increased production from wild fish, and then, if necessary, to implement measures to increase spawning in tributaries of the reservoir.

Irrigators along foothills of the Madison Range will be contacted to determine the potential for entering into agreements to use TAC money to improve the efficiency of irrigation systems to reduce ditch loss of irrigation water. If such measures can be implemented, excess water remaining in the streams will provide an opportunity to enhance or initiate spawning runs up those tributaries, and diversify spawning and rearing sources for the Madison River fishery.

During the 2000 field season, rainbow trout young-of-the-year rearing habitat will be evaluated to assess the affect habitat characteristics have on whirling disease infection rate and severity. Habitat characteristics will be correlated with young-of-the-year density and infection rate to assess whether the quality of rearing habitat affects the infectivity of young-of-the-year rainbow trout. Surveys by other researchers will determine the presence and proximity of whirling disease source 'hot-spots'. Additionally, sentinel cages with young-of-the-year rainbow trout will be transferred between various rearing sites to mimic migration. Samples of young-of-the-year rainbows will be removed from the cages during each move to assess infection rate at the last rearing site and cumulative infection. Sampled fish will be processed through standard protocols for analyses of whirling disease infection.

In the Bypass reach of the Madison River between Ennis Dam and powerhouse, radio telemetry will be used to monitor year-long movements of trout to determine the use of the Bypass for spawning. Additionally, surveys will be conducted in the Beartrap Canyon to determine the availability and use of spawning gravel. The intent of this work is to determine whether gravel should be added to the Bypass Reach to enhance its suitability for spawning.

Pending the outcome of the Cherry Creek appeal, that project is set to go forth in 2000. Several other streams are candidates for westslope cutthroat projects. This includes streams for which the landowner has solicited FWP to assess the feasibility of conducting such projects.

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Appendix A

Description of young-of-the-year grayling beach seining locations in Ennis Reservoir, and catch at each site. See Figure 2 for sites.

Species abbreviations:

AG	arctic grayling
MWF	mountain whitefish
WSu	white sucker

September 22, 1999

Site seined/time	AG	MWF	Note
Willows at edge of Peterson property to next willows to west (Fig 4, site 1) 1200 hrs	0	3	macrophytes sparse throughout bay
along second willow patch (Fig 4, site 1) 1328 hrs	2	19	some WSu
along willows at `` Meadow Lake FAS (Fig 4, site 1) 1356 hrs	0	2	
along shore west of Moore's Creek mouth (Fig 4, site 2) 1425 hrs	0	10	
along shore west of river mouth (Fig 4, site 3) 1450 hrs	0	0	few WSu, 1 Sc

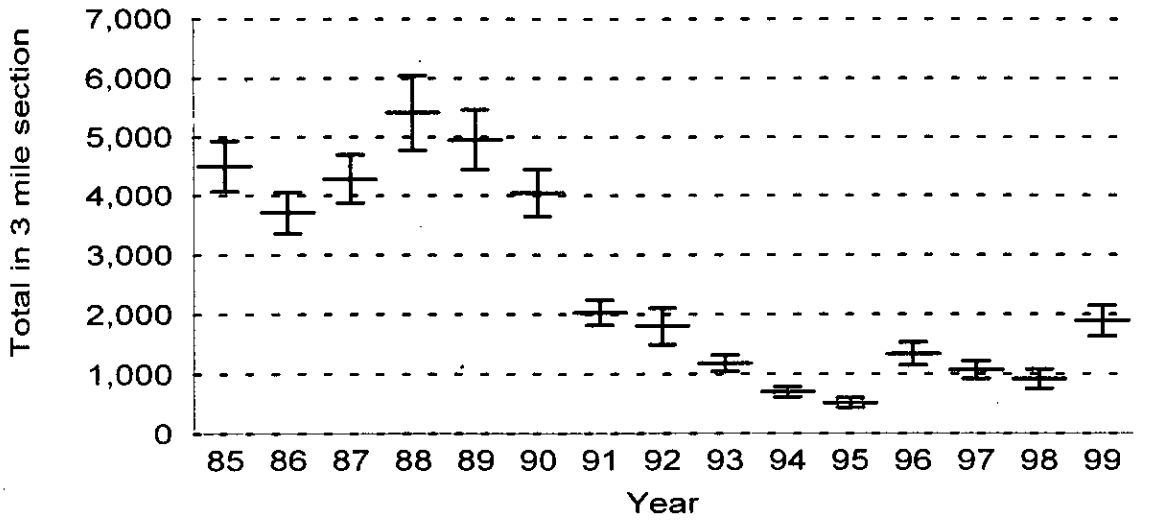
Appendix B

Population estimates (total number for section) of age 2 & older *rainbow and brown trout in the Madison River* ± 80 percent Confidence Intervals

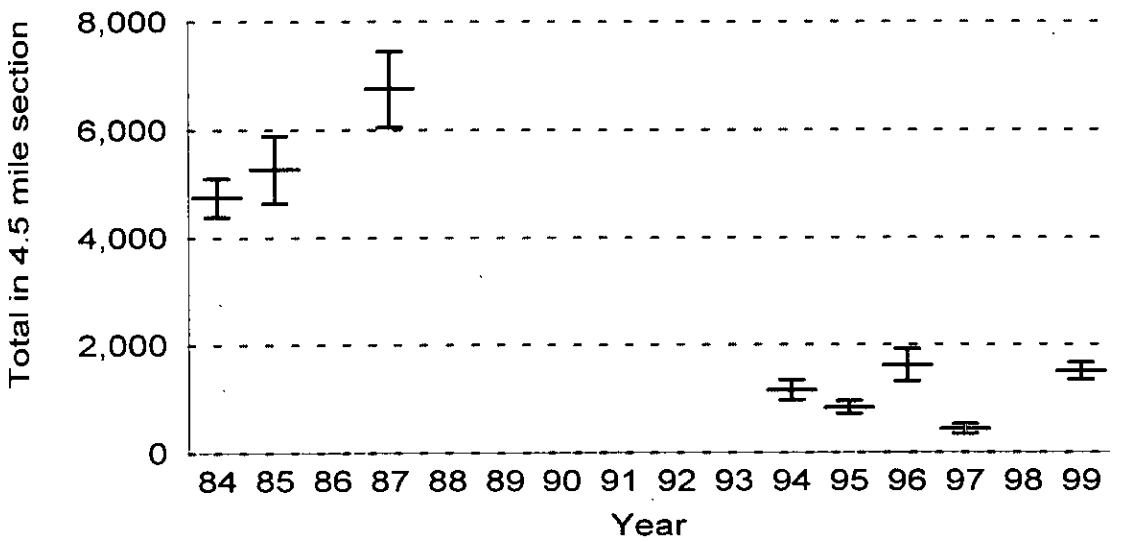
section lengths

Pine Butte - 3 miles
Snoball - 4.5 miles
Varney - 4 miles
Norris - 4 miles

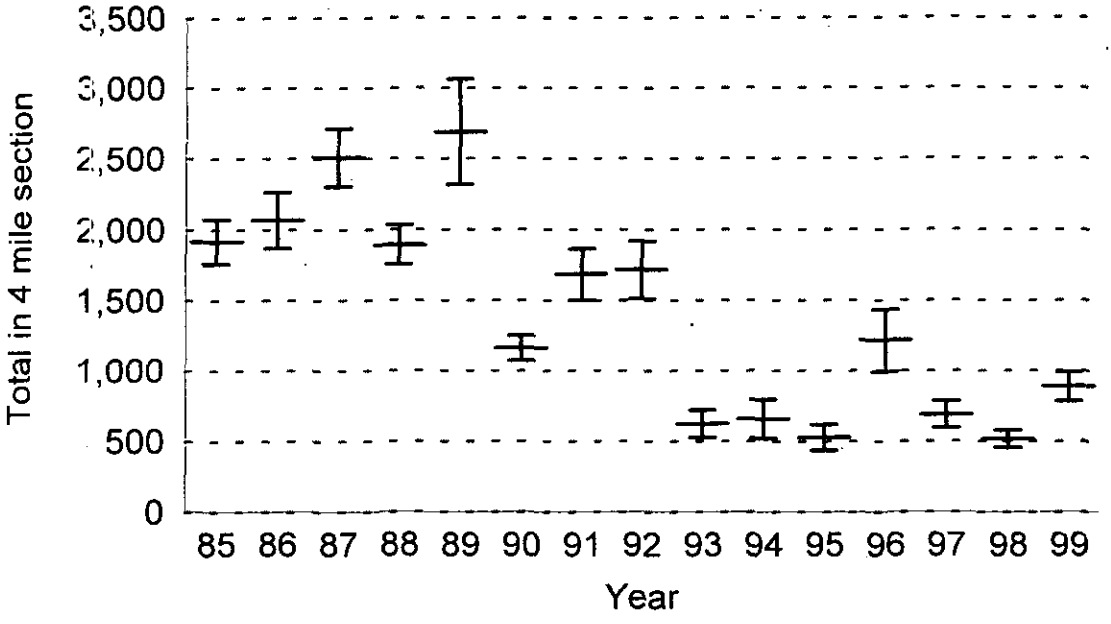
Pine Butte
Rainbow Trout
Age 2 & older



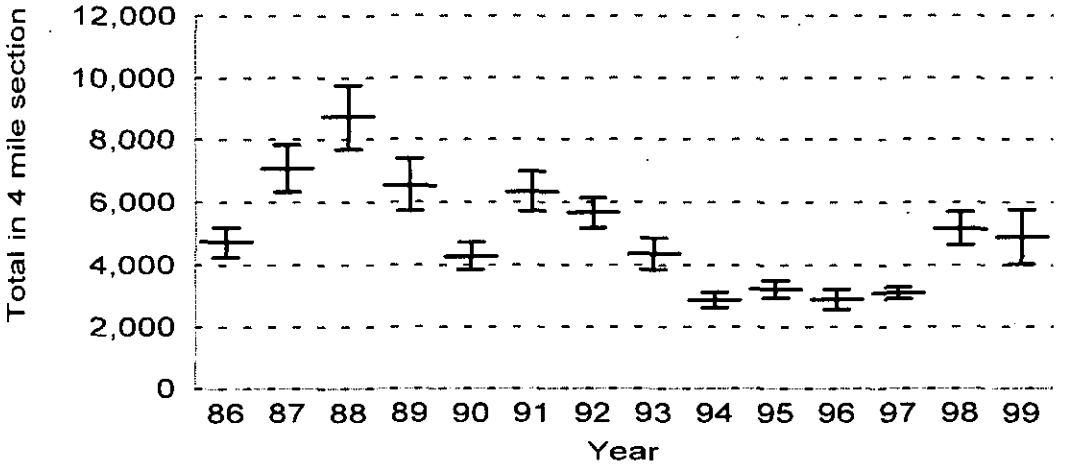
Snoball
Rainbow Trout
Age 2 & Older



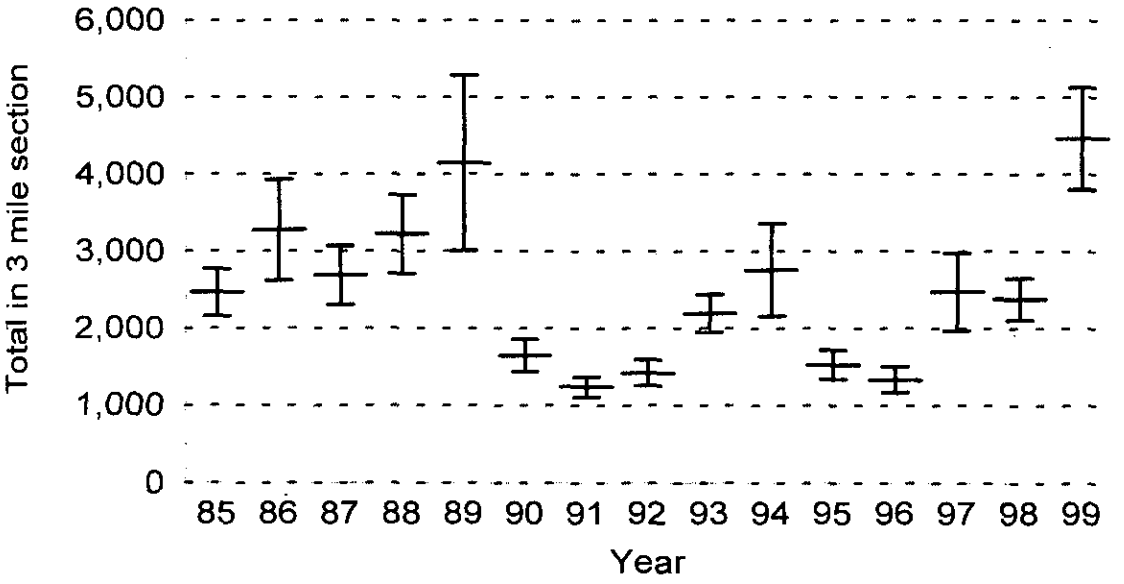
Varney
Rainbow Trout
Age 2 & Older



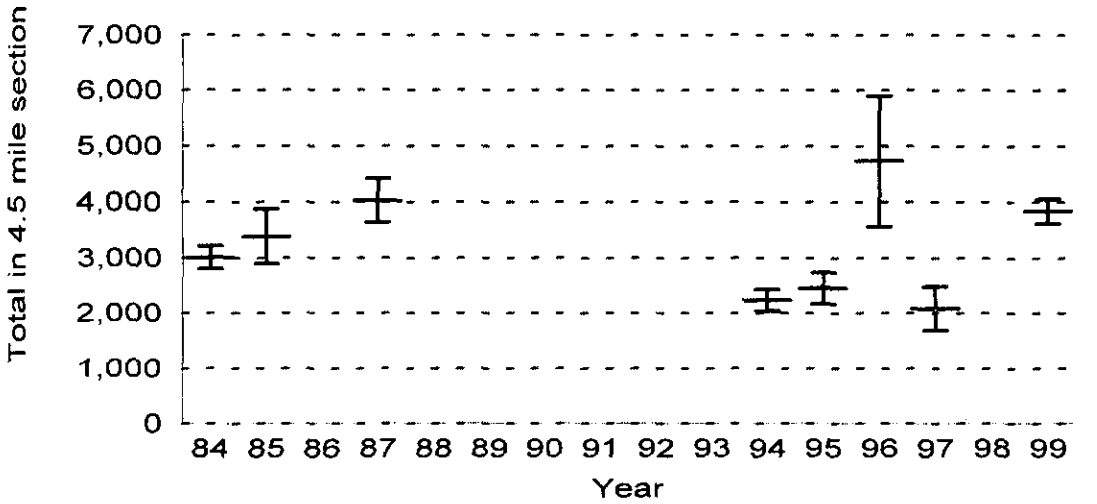
Norris
Rainbow Trout
Age 2 & Older



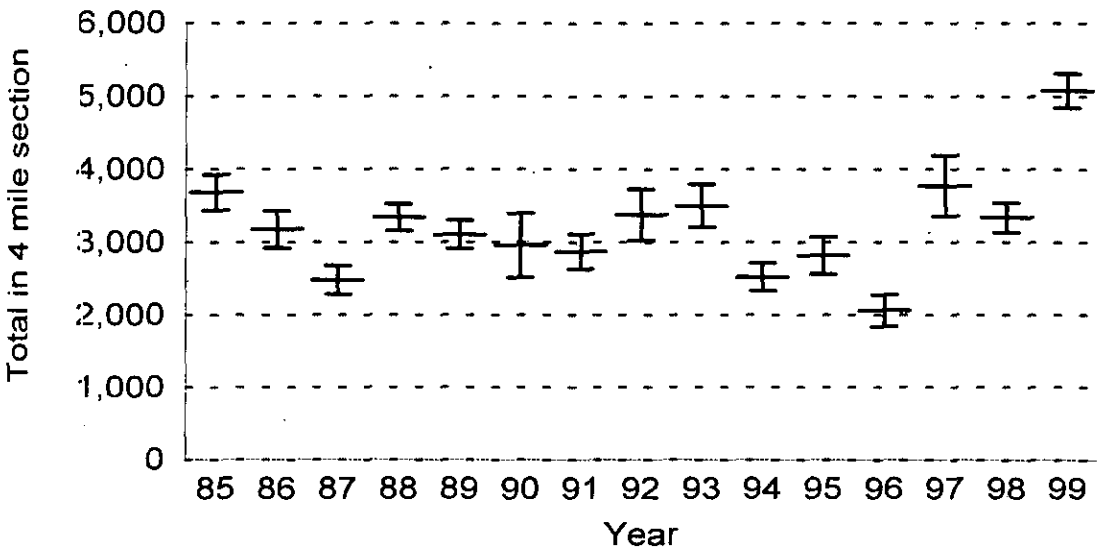
Pine Butte
Brown Trout
Age 2 & older



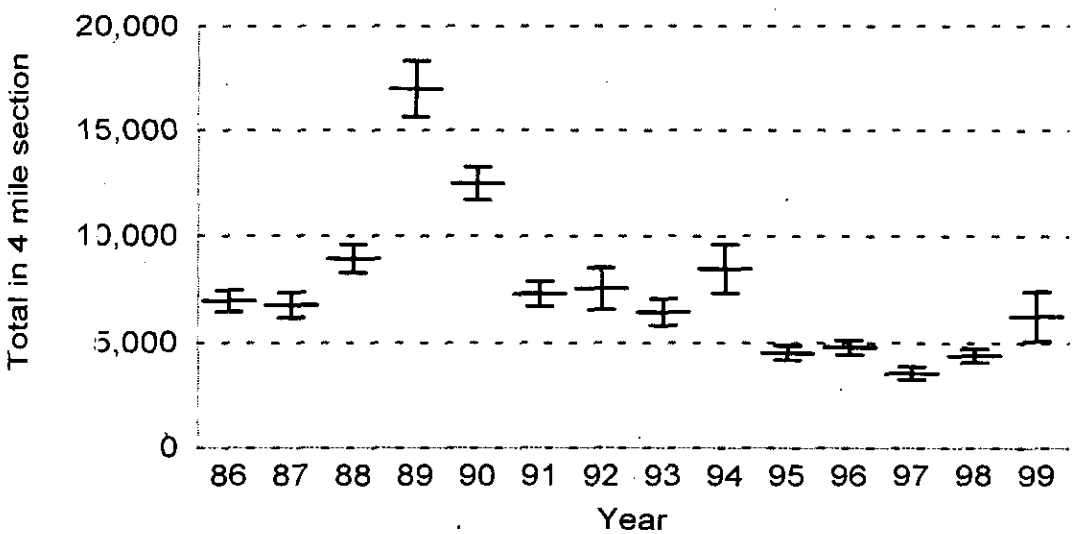
Snoball
Brown Trout
Age 2 & Older



Varney
Brown Trout
Age 2 & Older

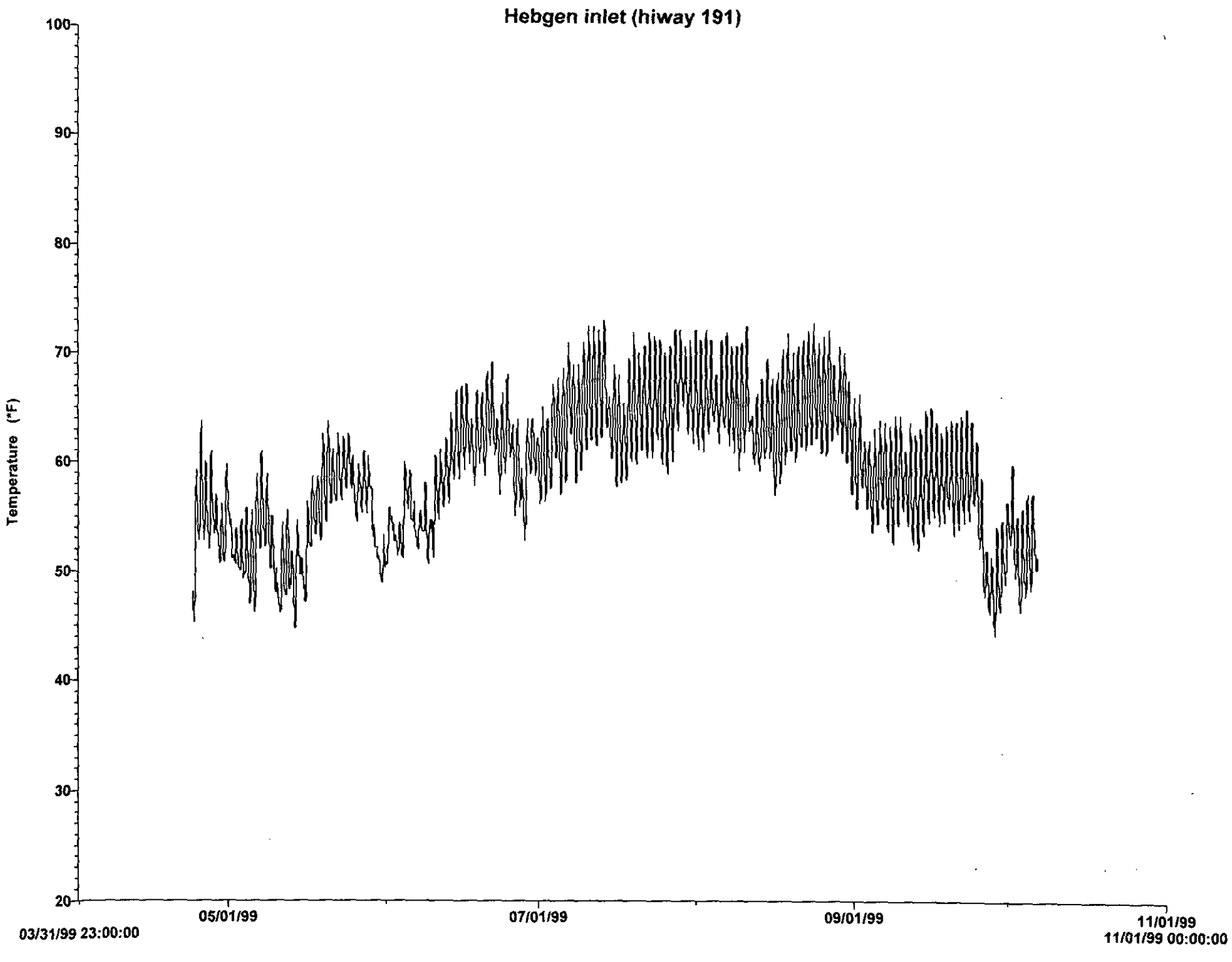


Norris
Brown Trout
Age 2 & Older



Appendix C1

Temperature recordings from monitoring sites on the Madison River
(See Figure 4 for locations)


Hebgen inlet (hiway 191)
Temperature (°F)
100
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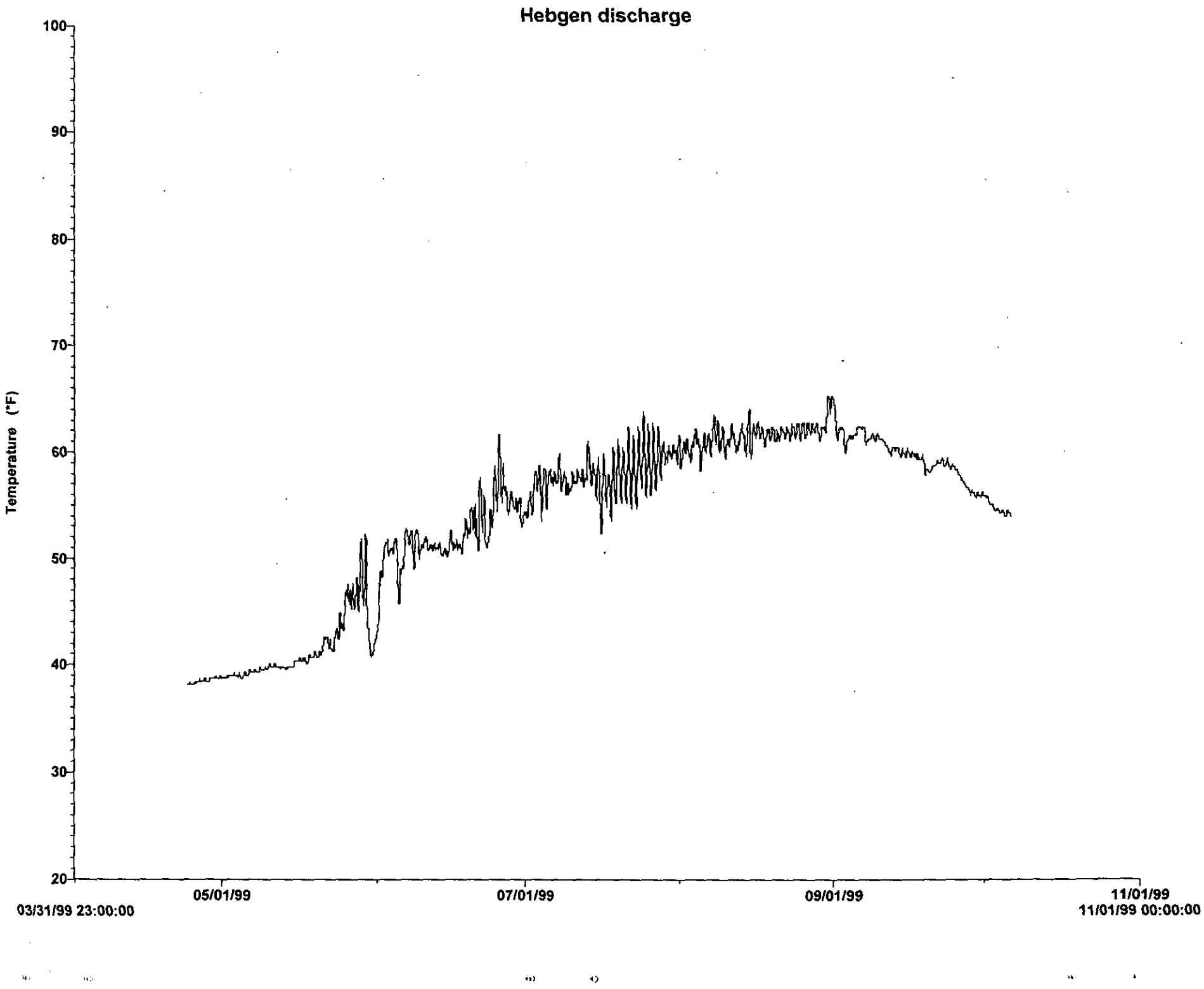
03/31/99 23:00:00
05/01/99
07/01/99
09/01/99
11/01/99
11/01/99 00:00:00


Hebgen discharge
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Temperature (°F)
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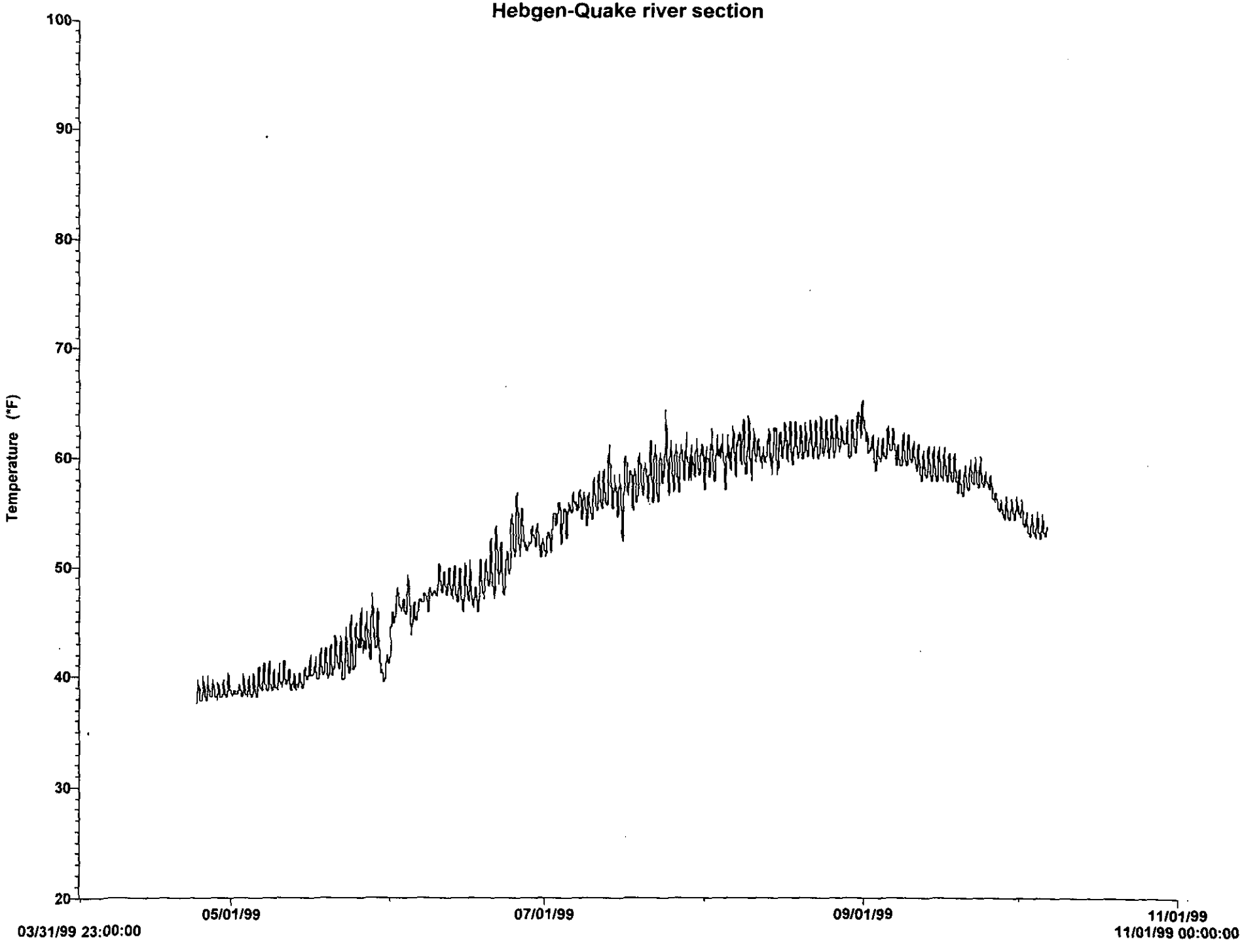
Hebgen-Quake river section
Temperature (°F)
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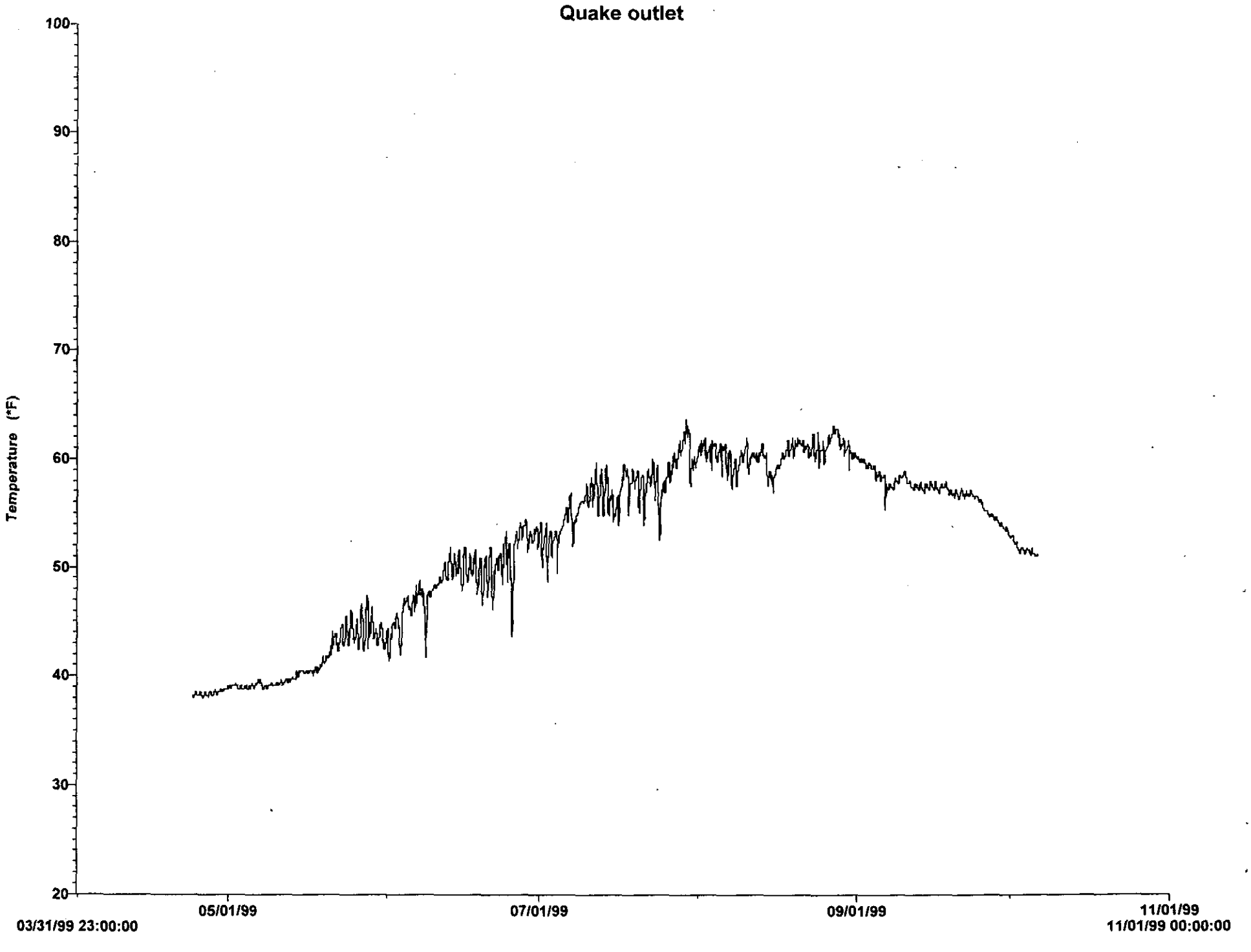
Quake outlet
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Temperature (°F)
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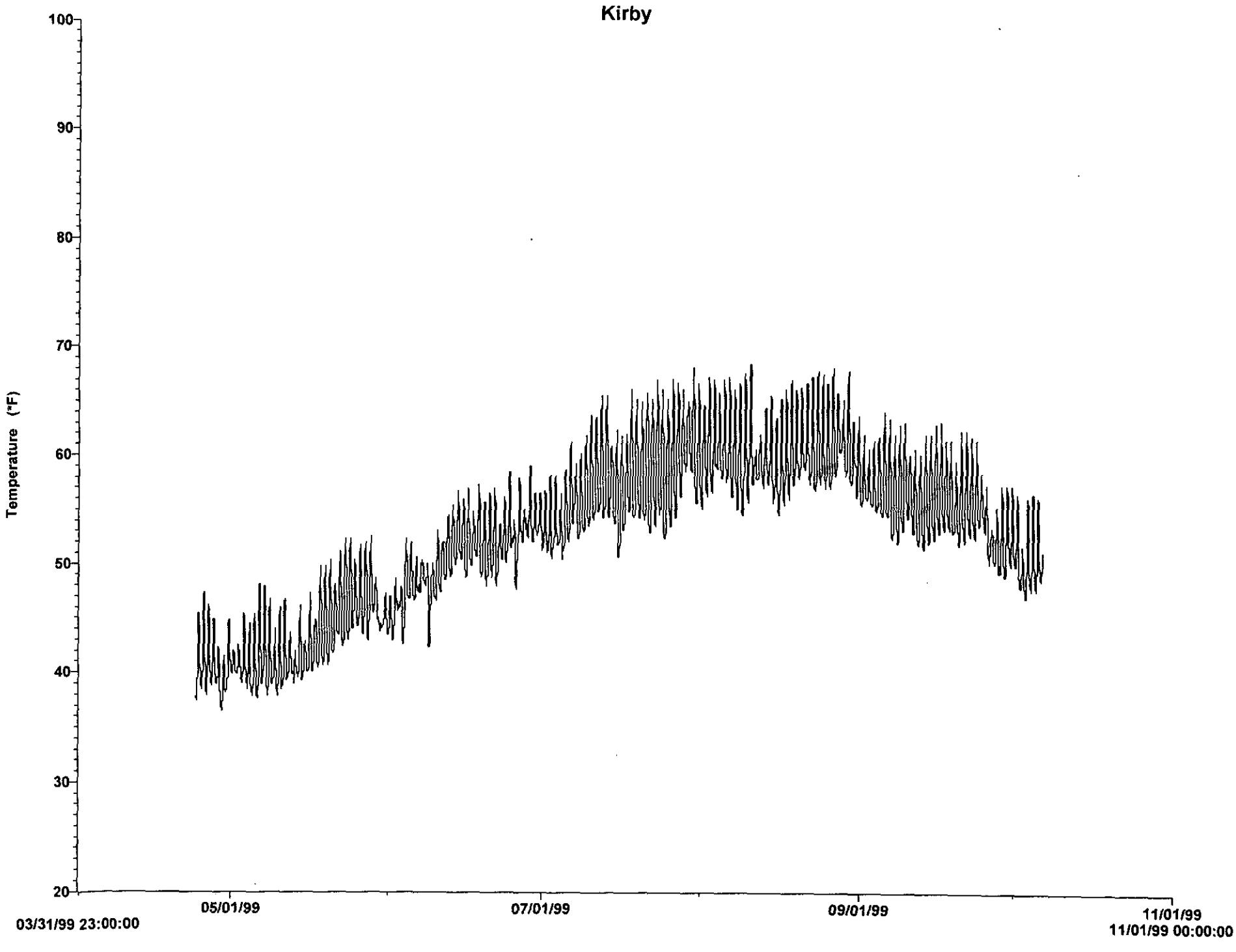
Kirby
Temperature (°F)
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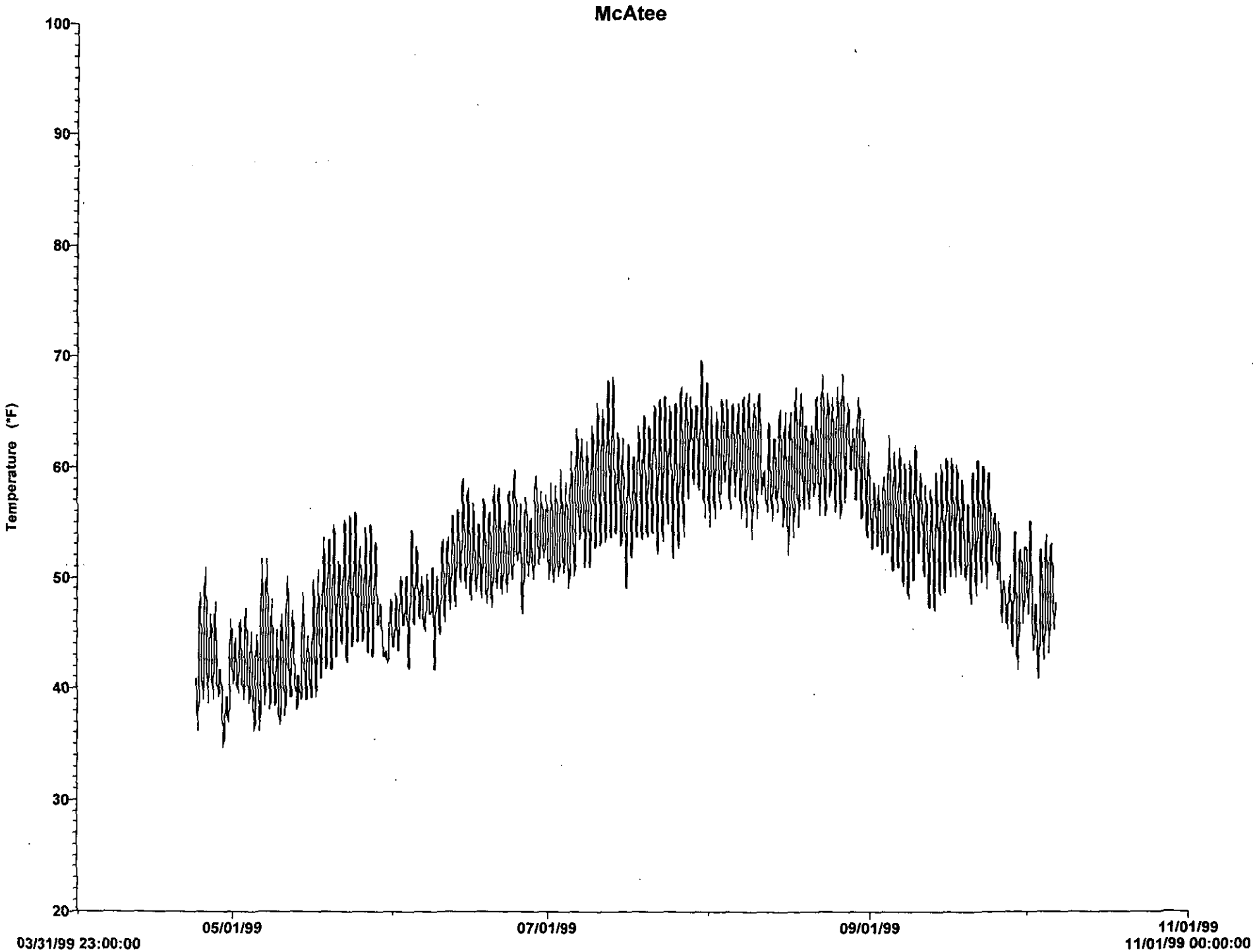
McAtee
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Temperature (°F)
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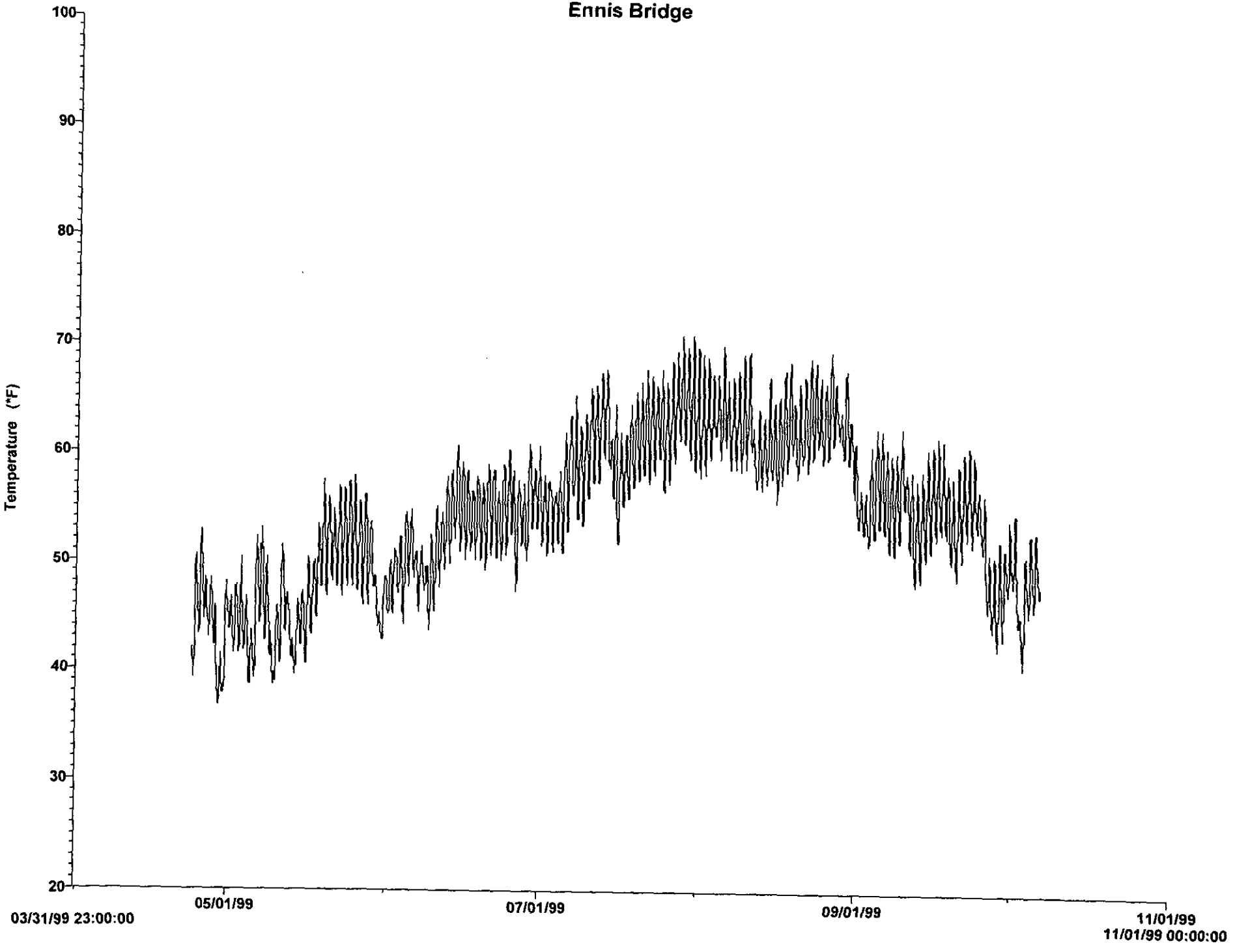
Ennis Bridge
Temperature (°F)
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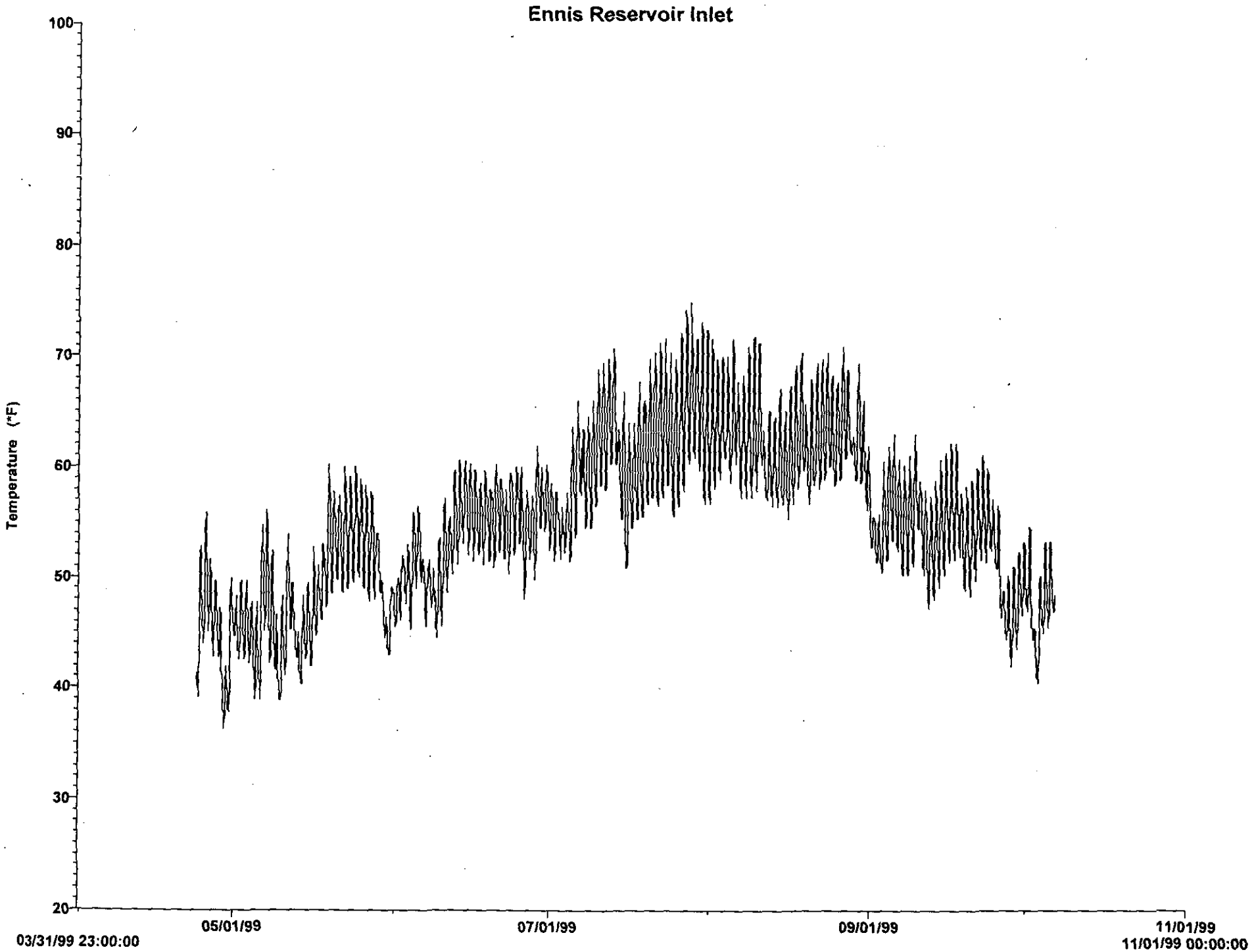
Ennis Reservoir Inlet
Temperature (°F)
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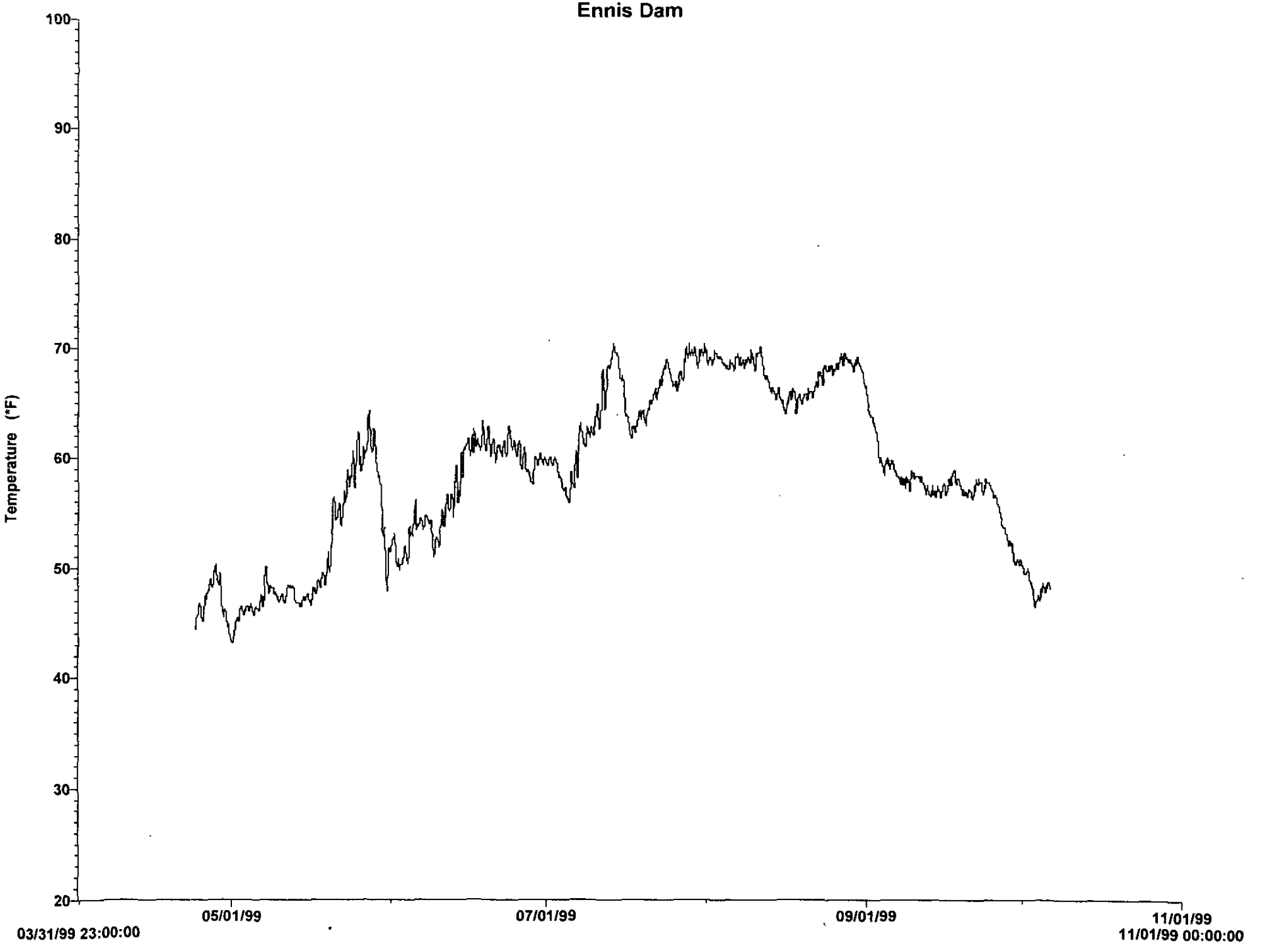
Ennis Dam
Temperature (°F)
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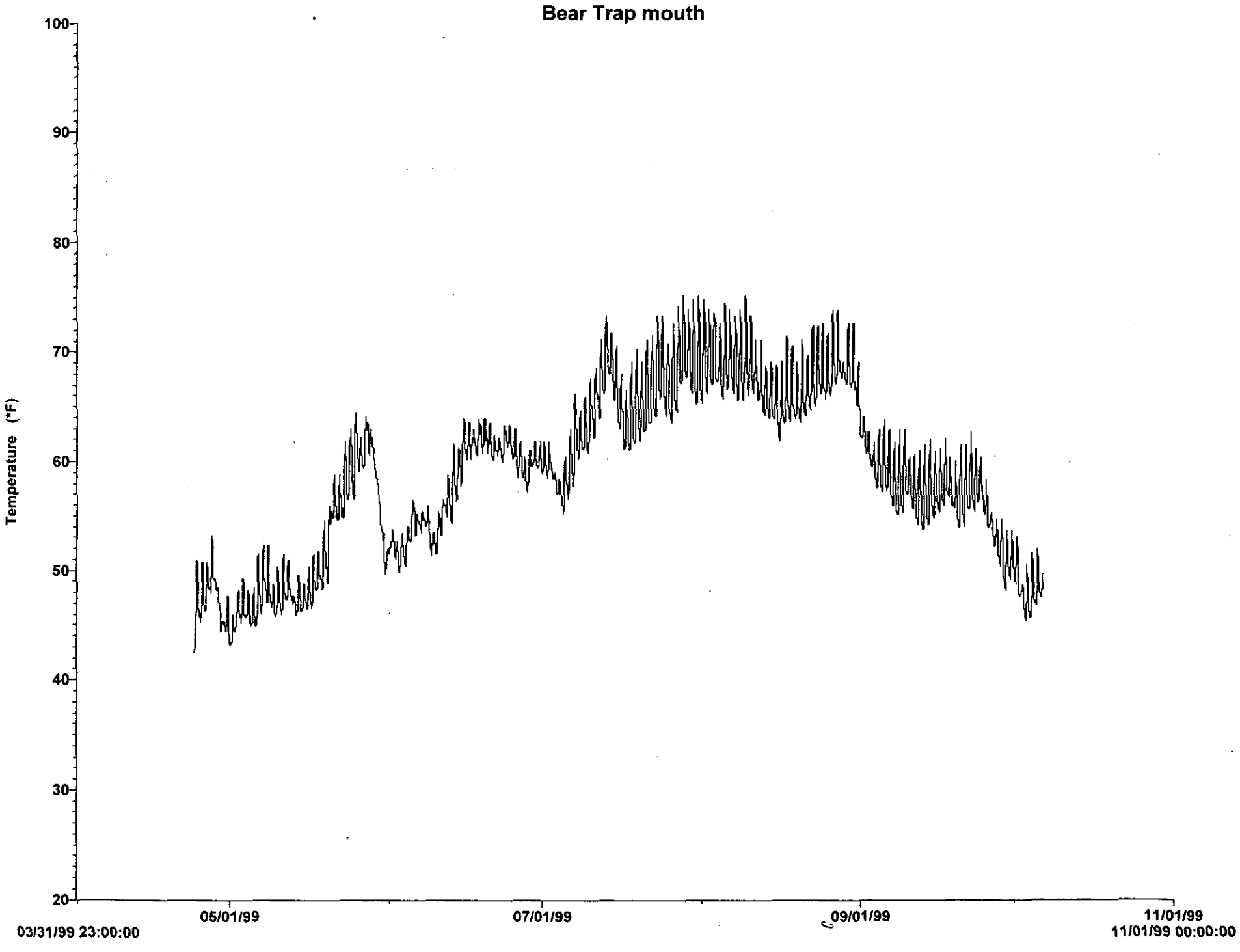
Bear Trap mouth
Temperature (°F)
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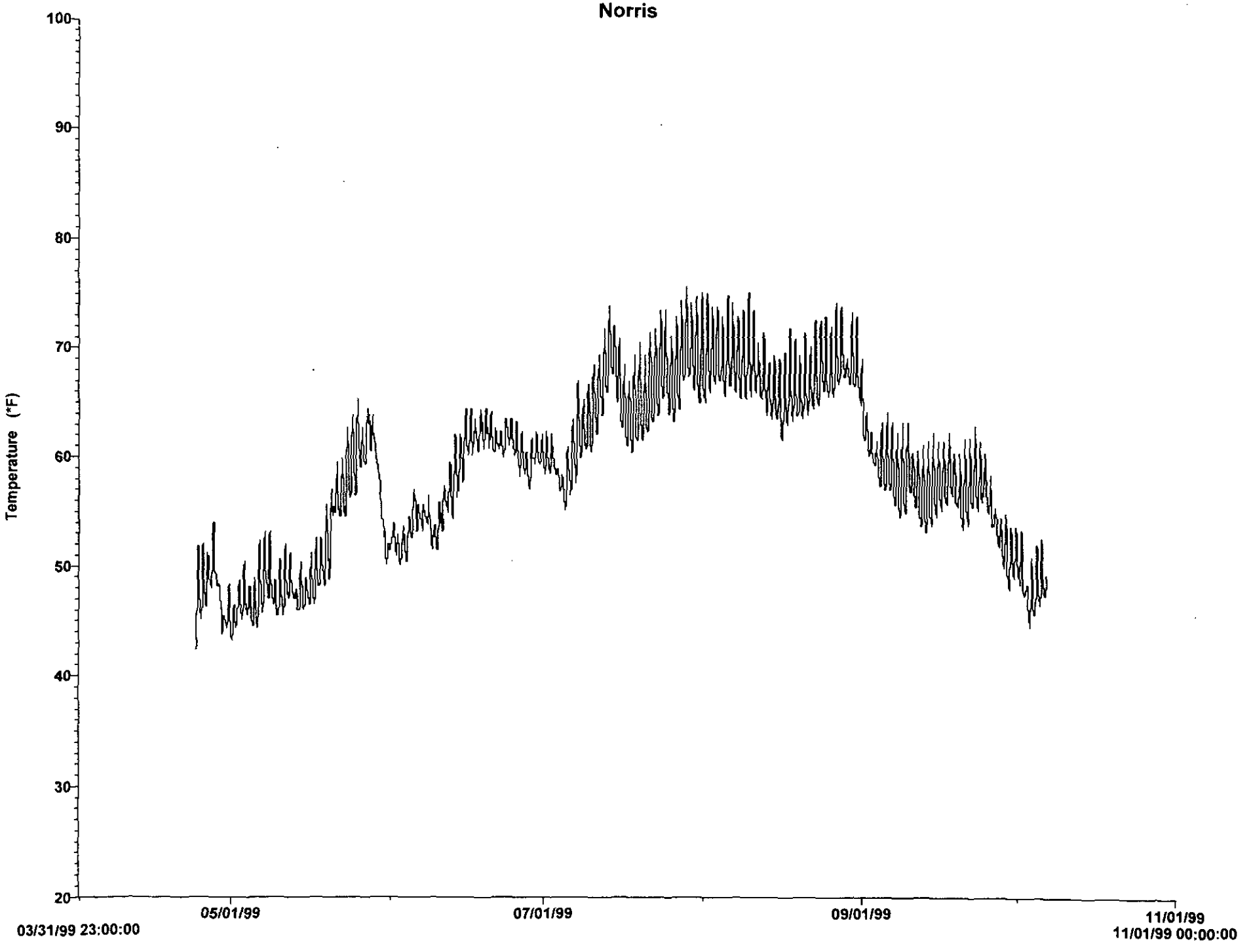
Norris
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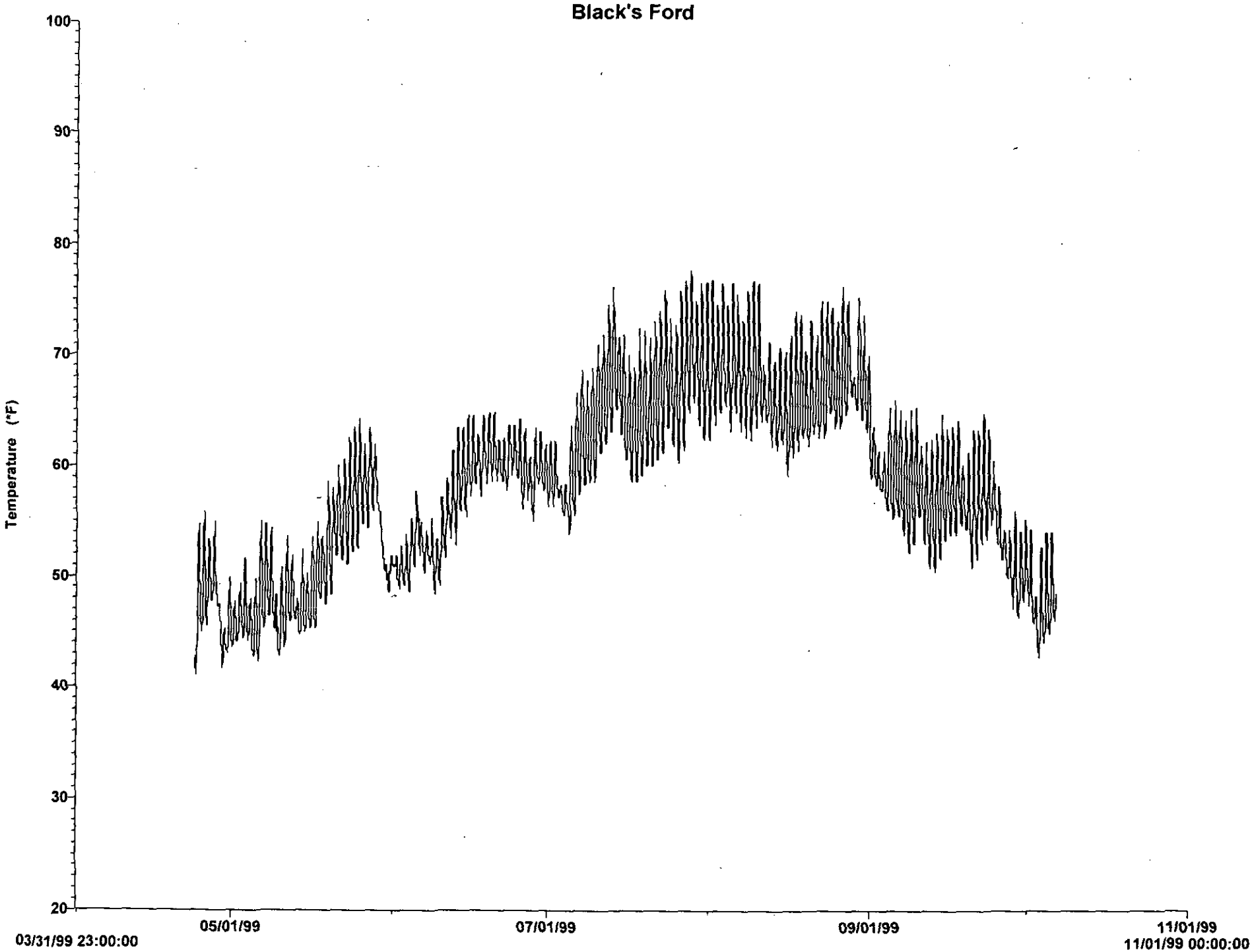
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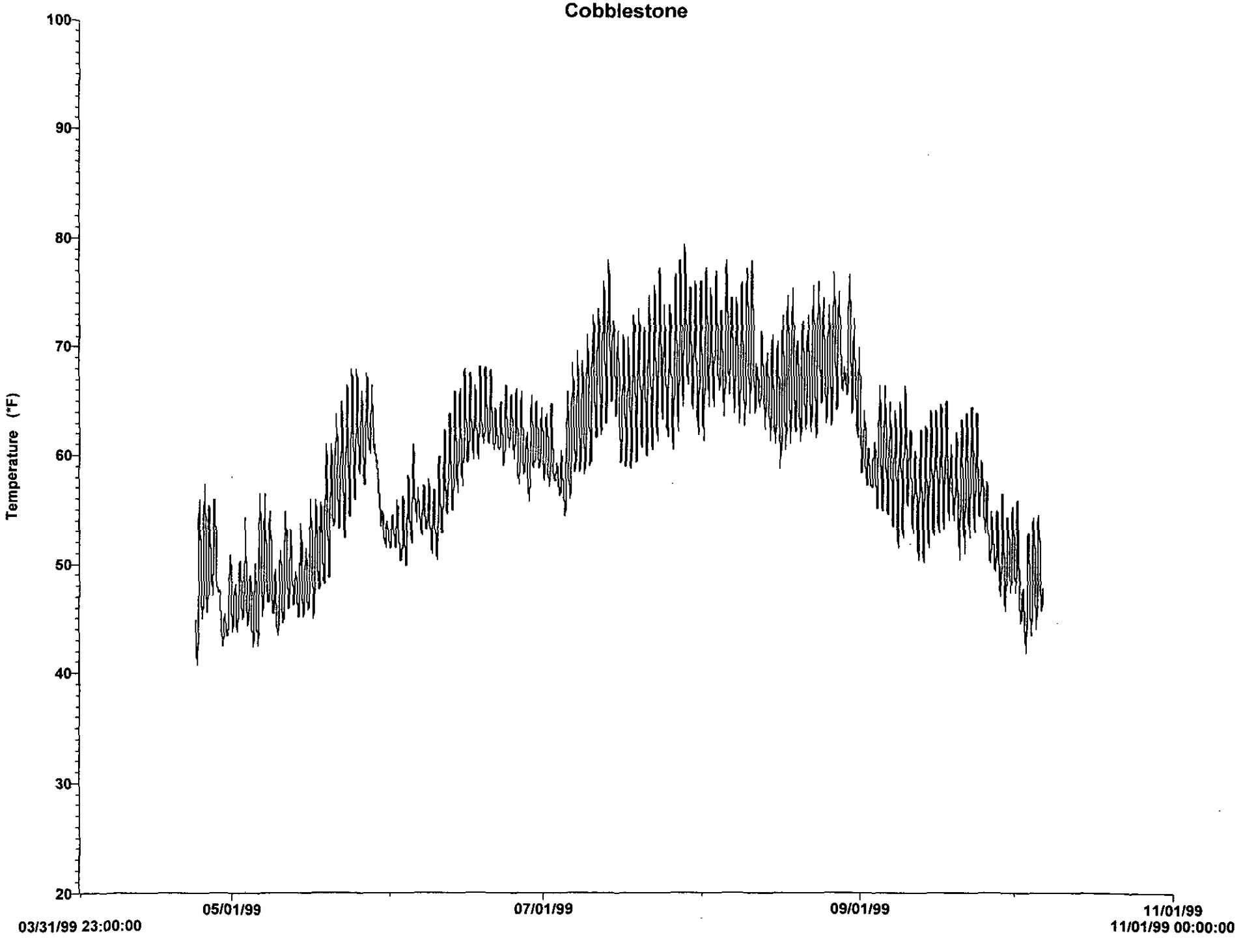
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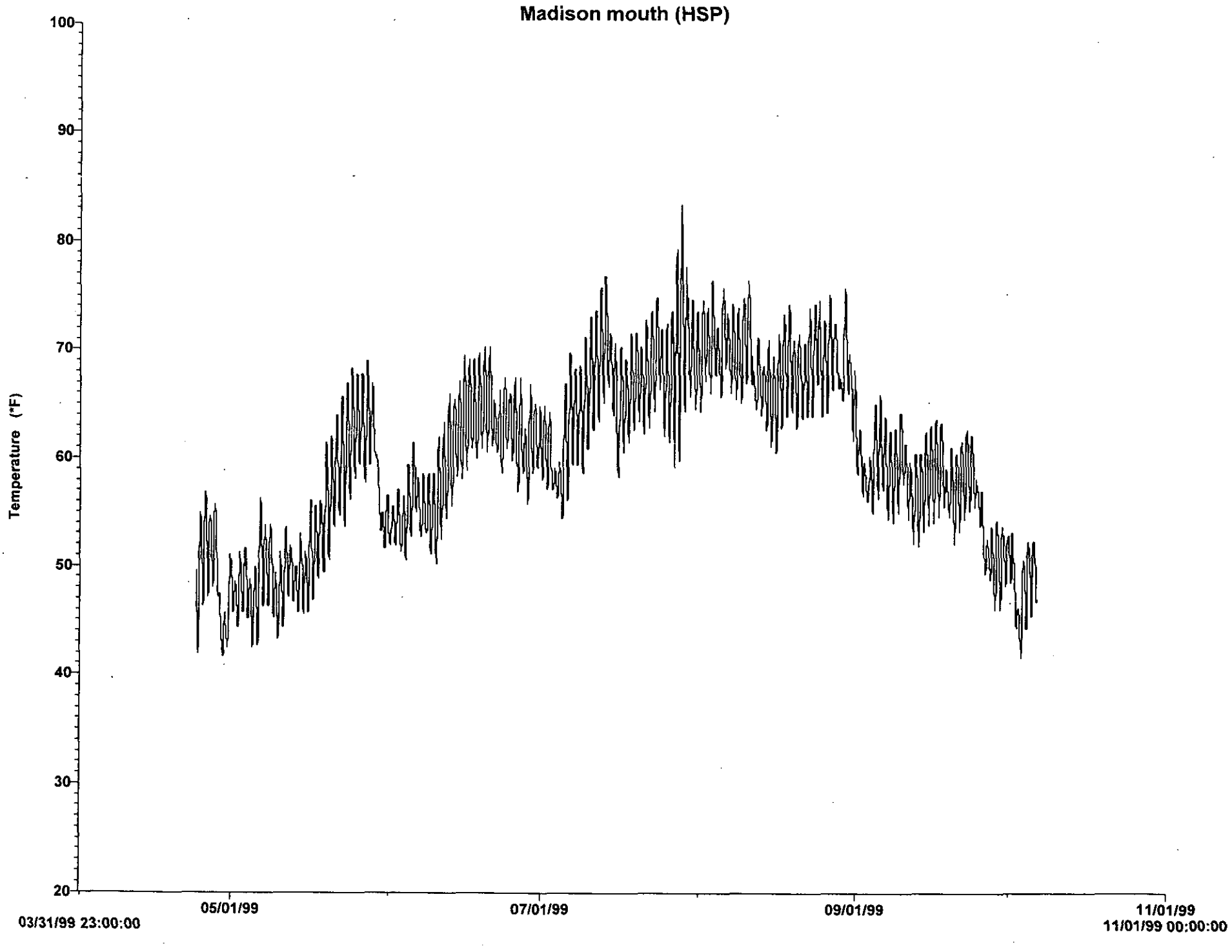
Madison mouth (HSP)
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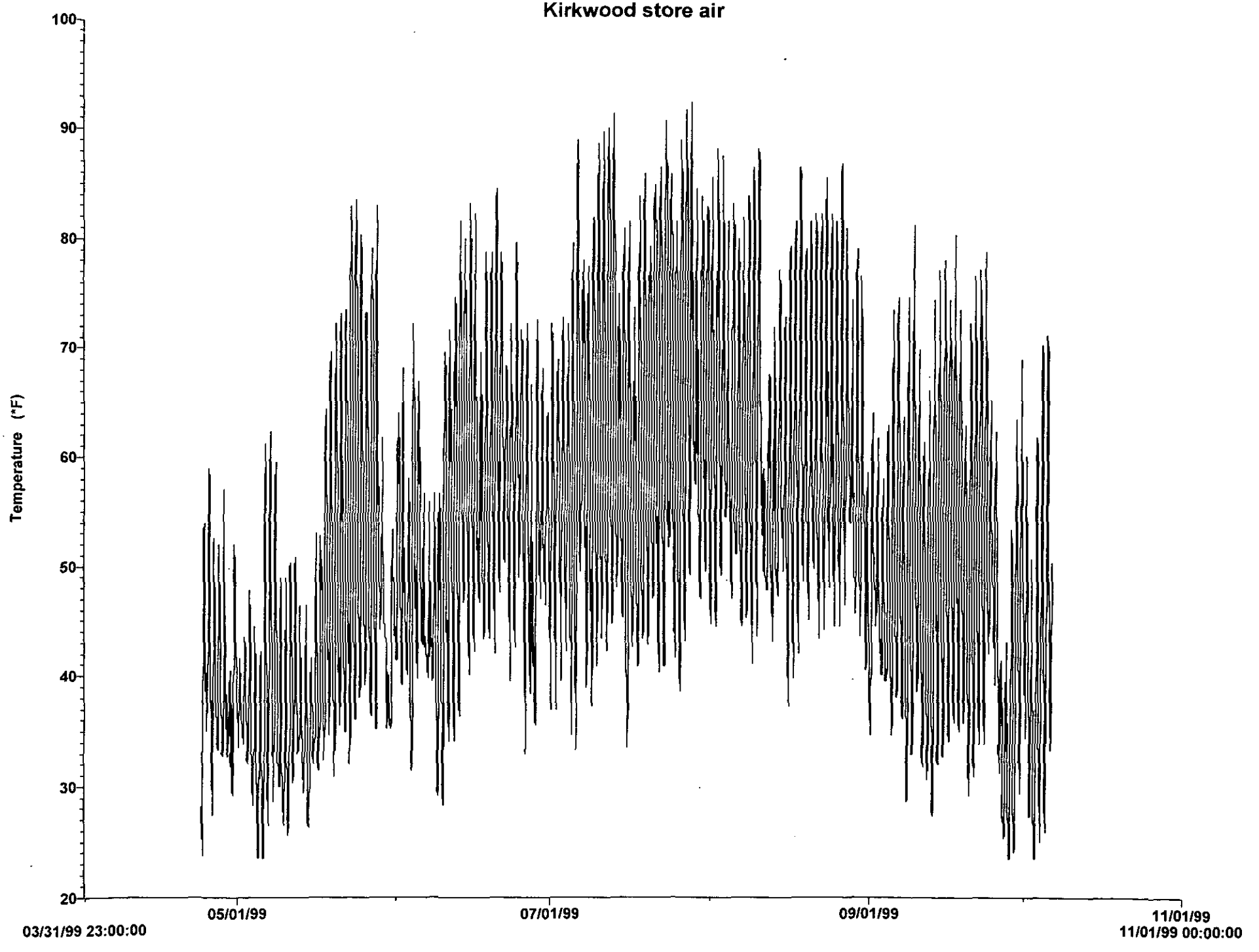
Kirkwood store air
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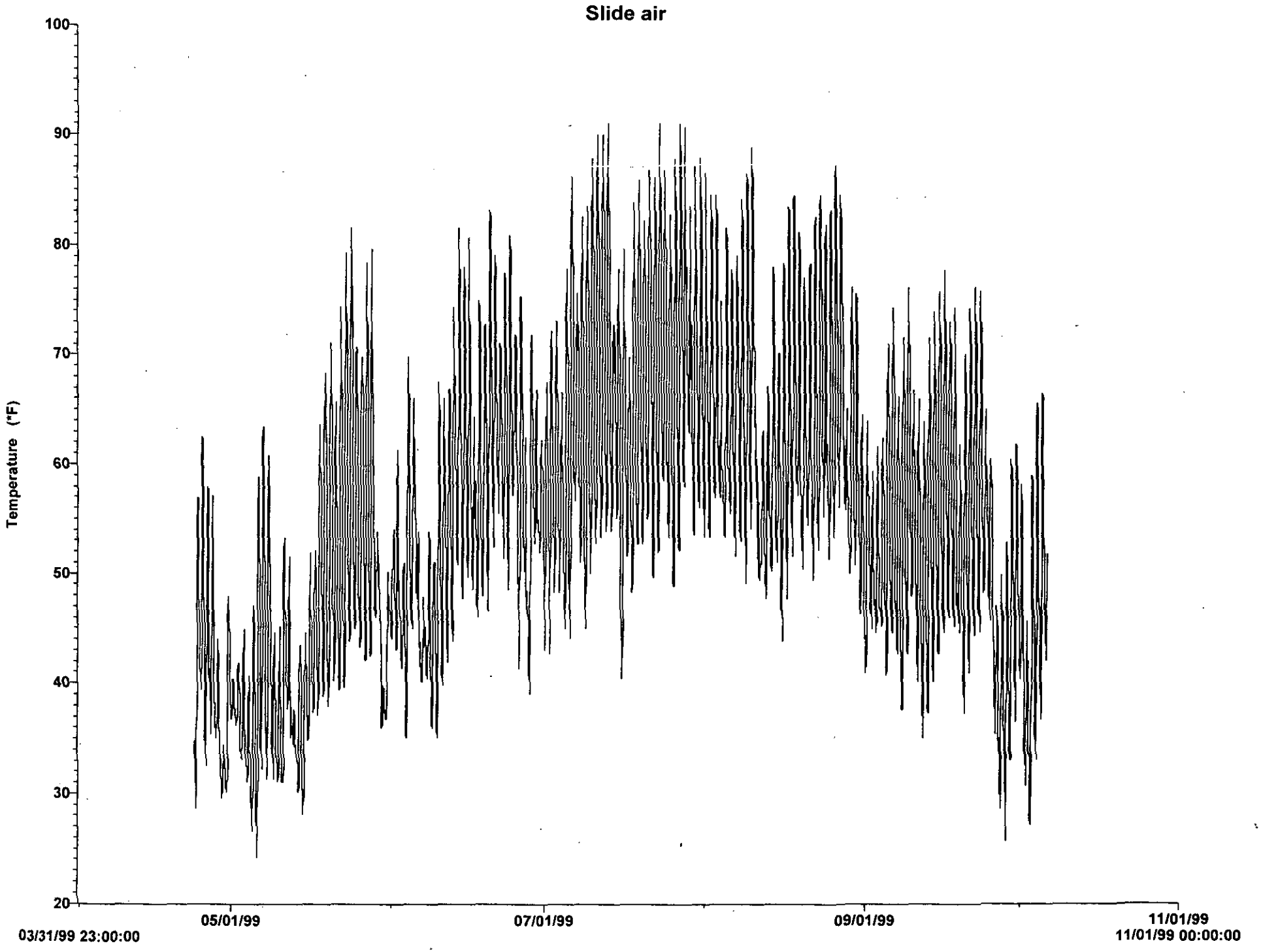
Slide air
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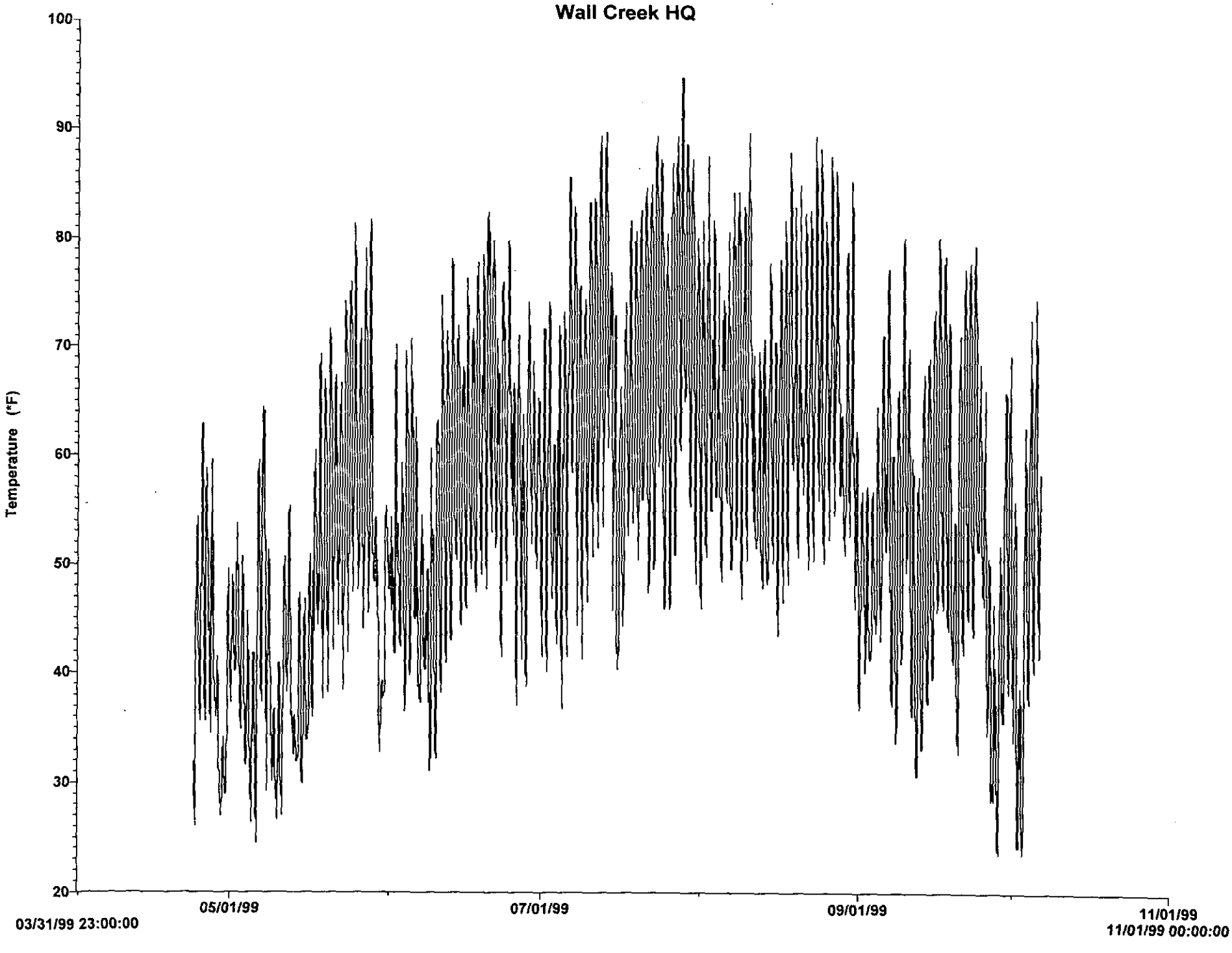
Wall Creek HQ
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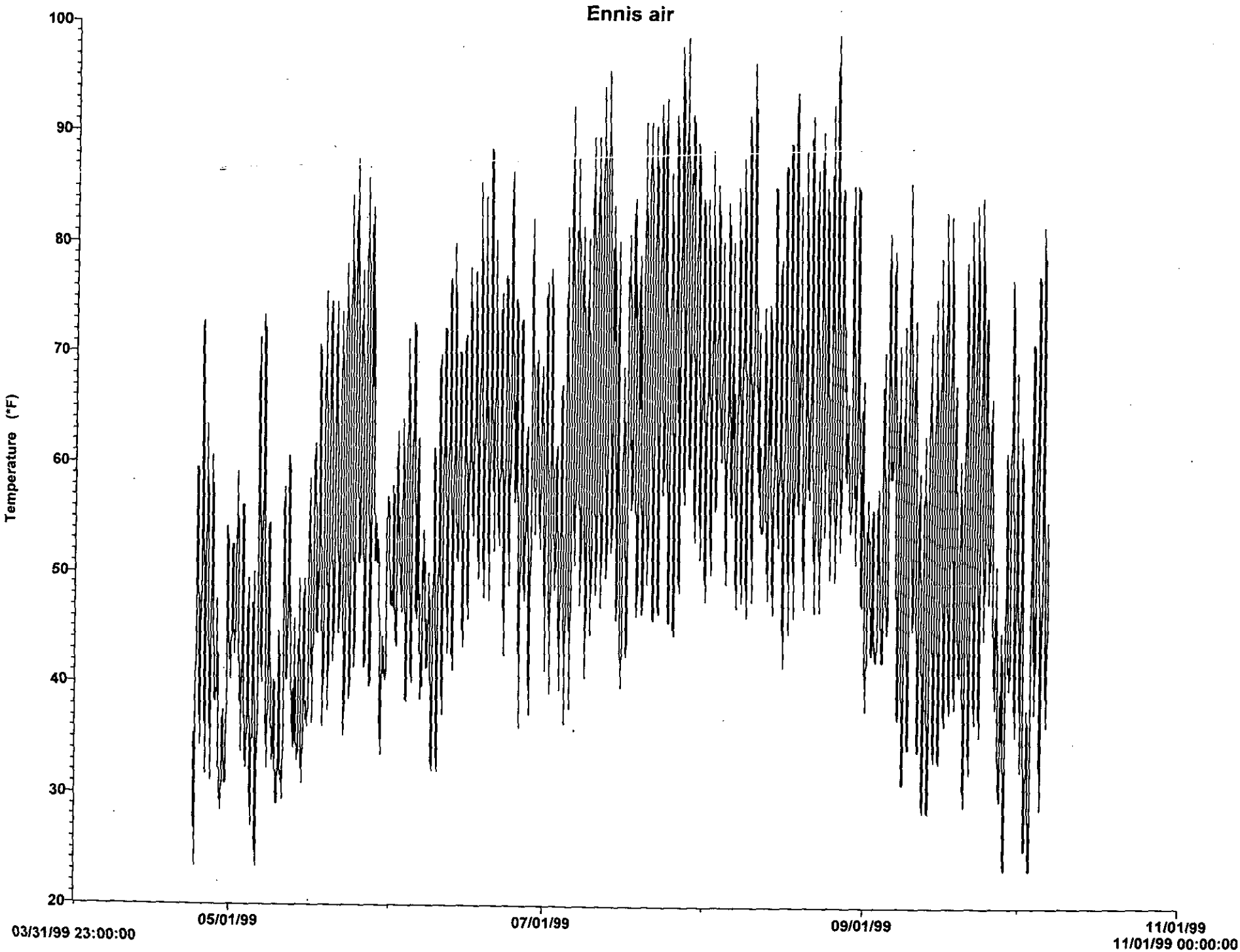
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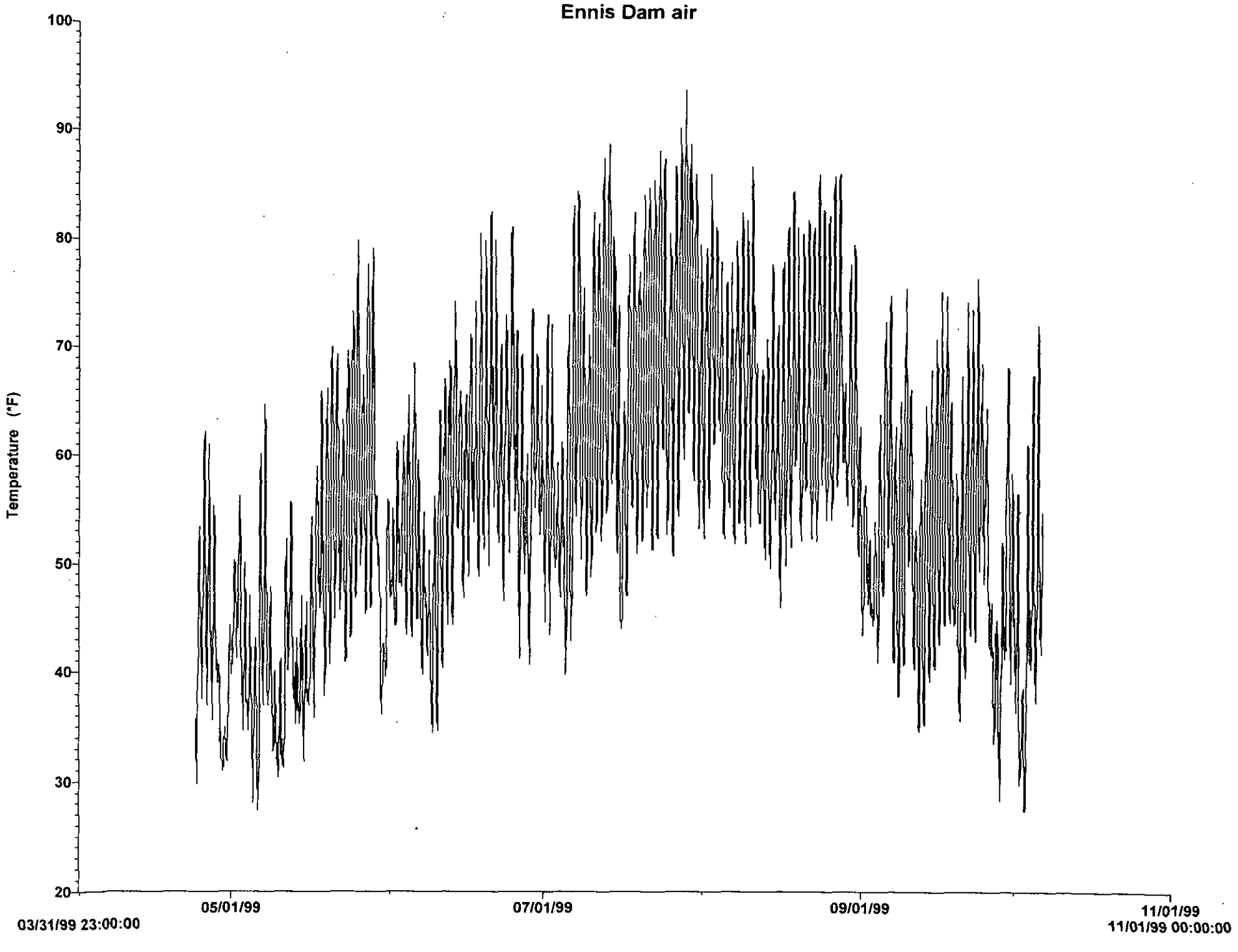
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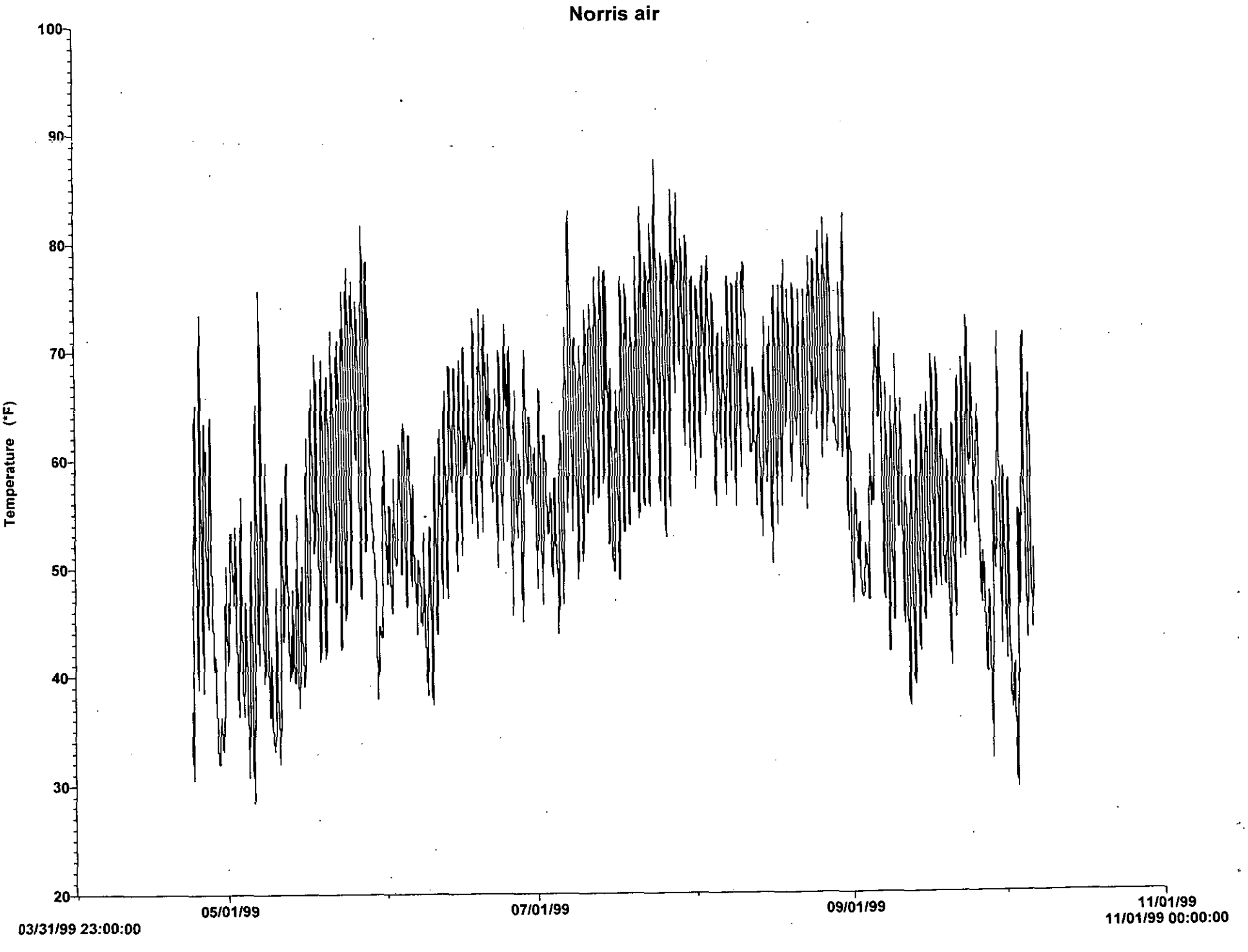
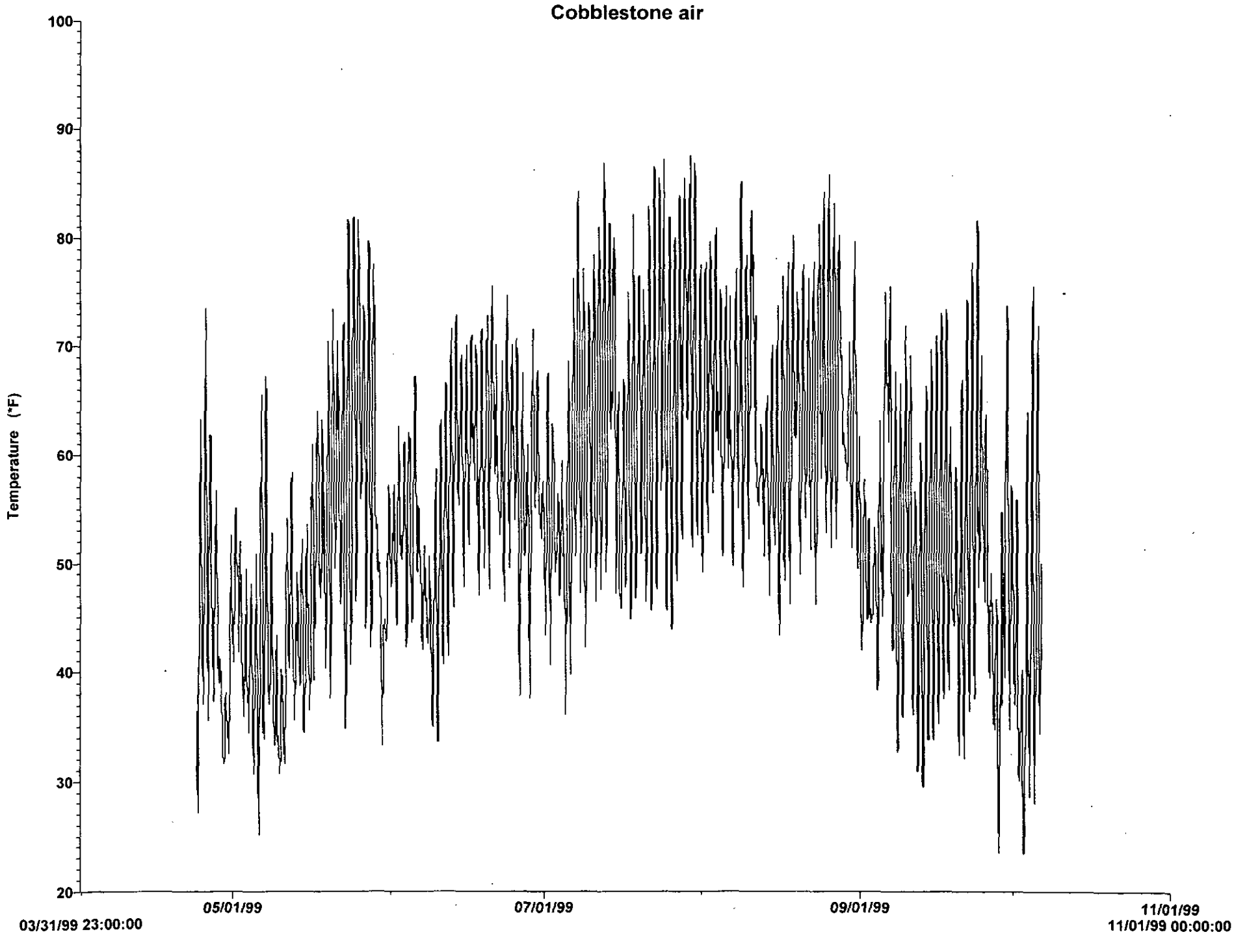
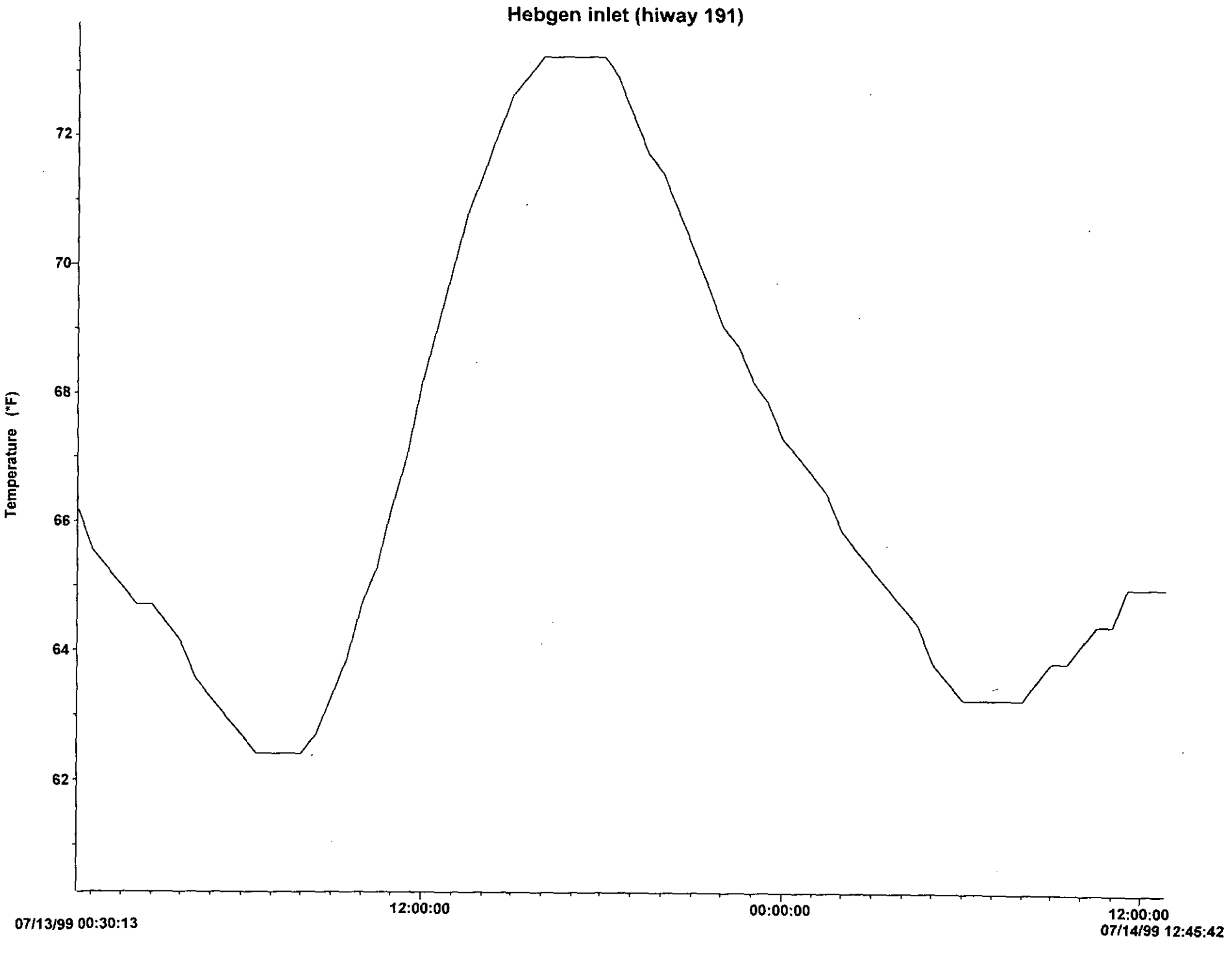
11/01/99 00:00:00

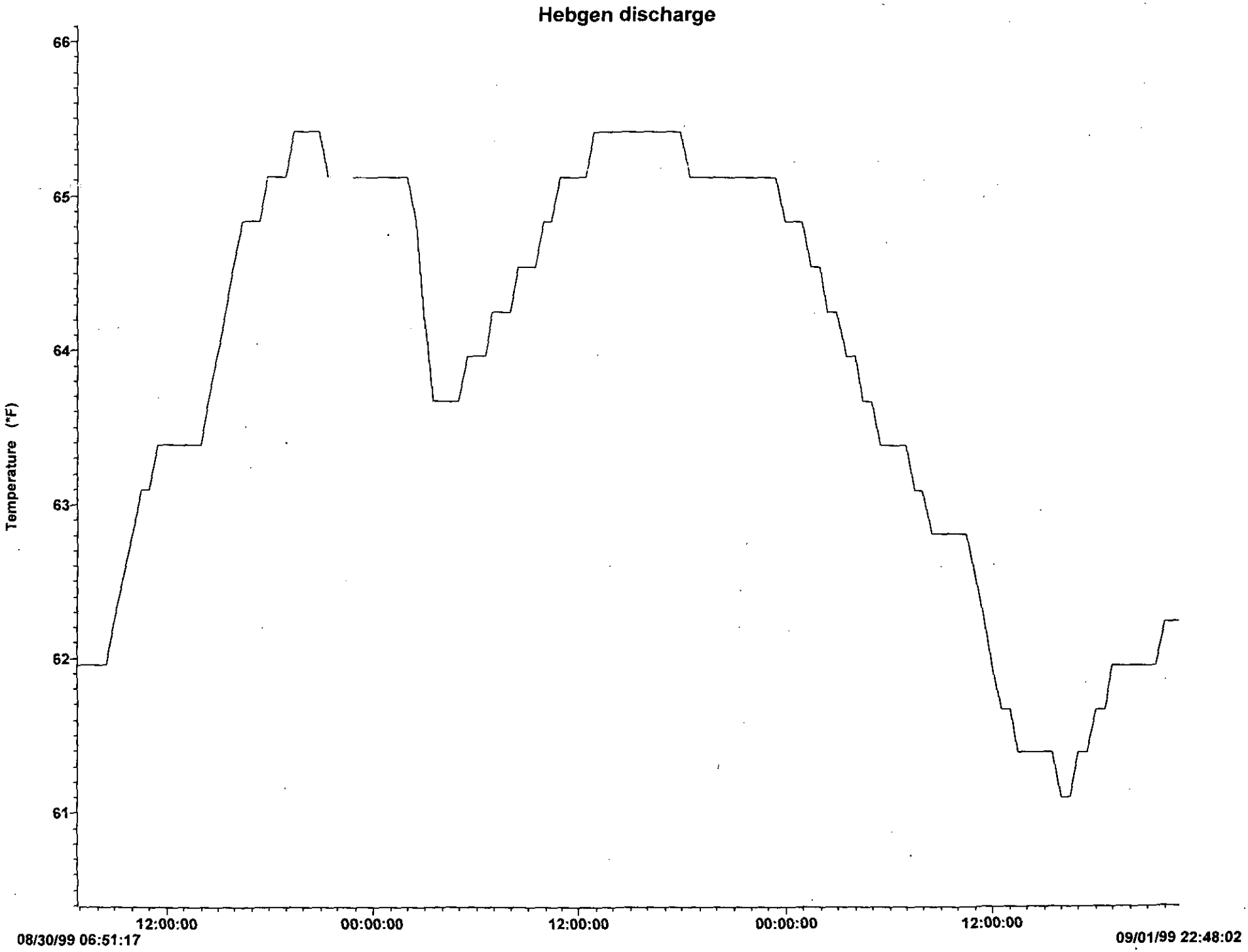

Norris air
100
90
80
70
60
50
40
30
20
Temperature (°F)
03/31/99 23:00:00
05/01/99
07/01/99
09/01/99
11/01/99
11/01/99 00:00:00

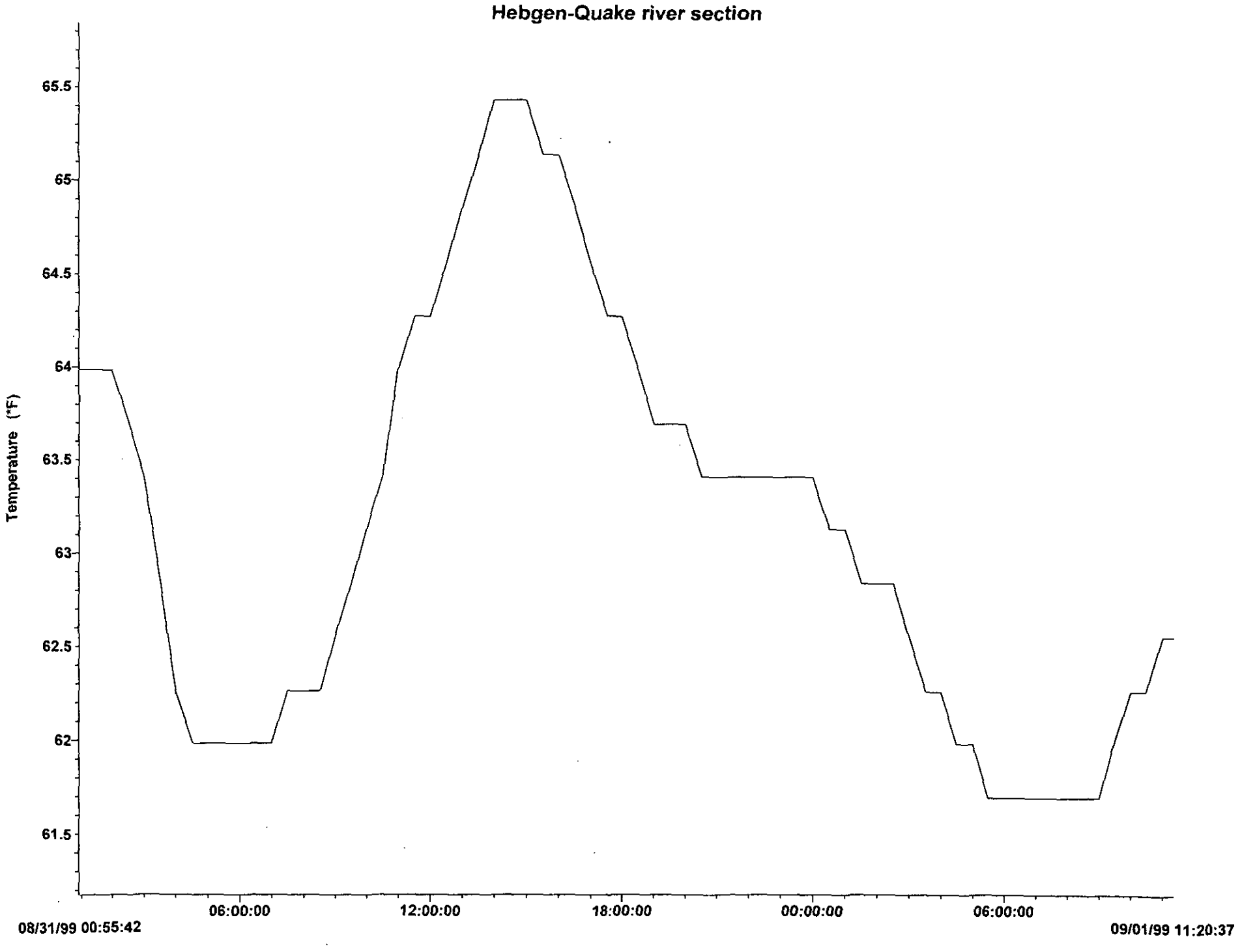

Cobblestone air
Temperature (°F)
100
90
80
70
60
50
40
30
20
05/01/99
07/01/99
09/01/99
11/01/99
03/31/99 23:00:00
11/01/99 00:00:00

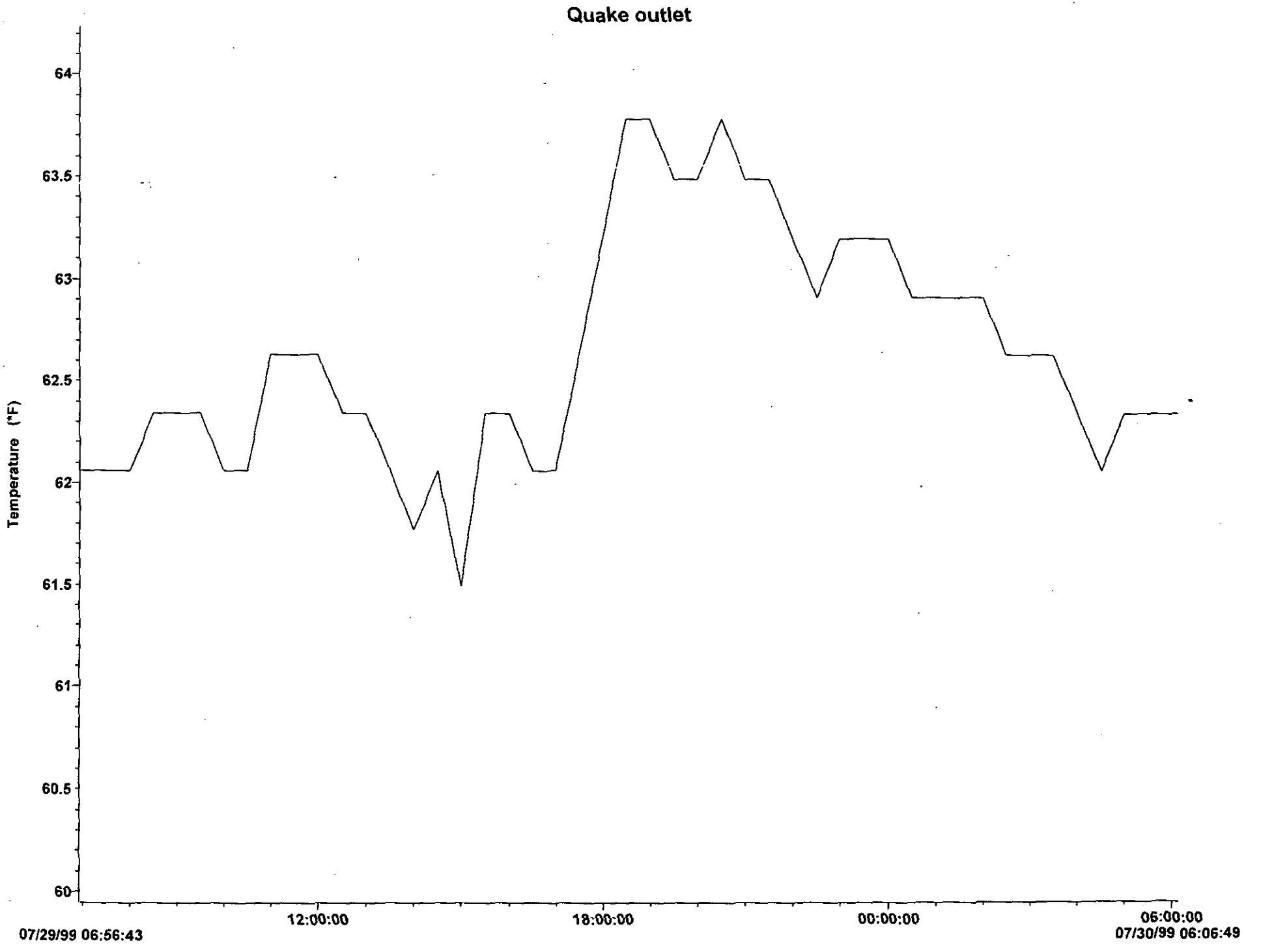
Appendix C2

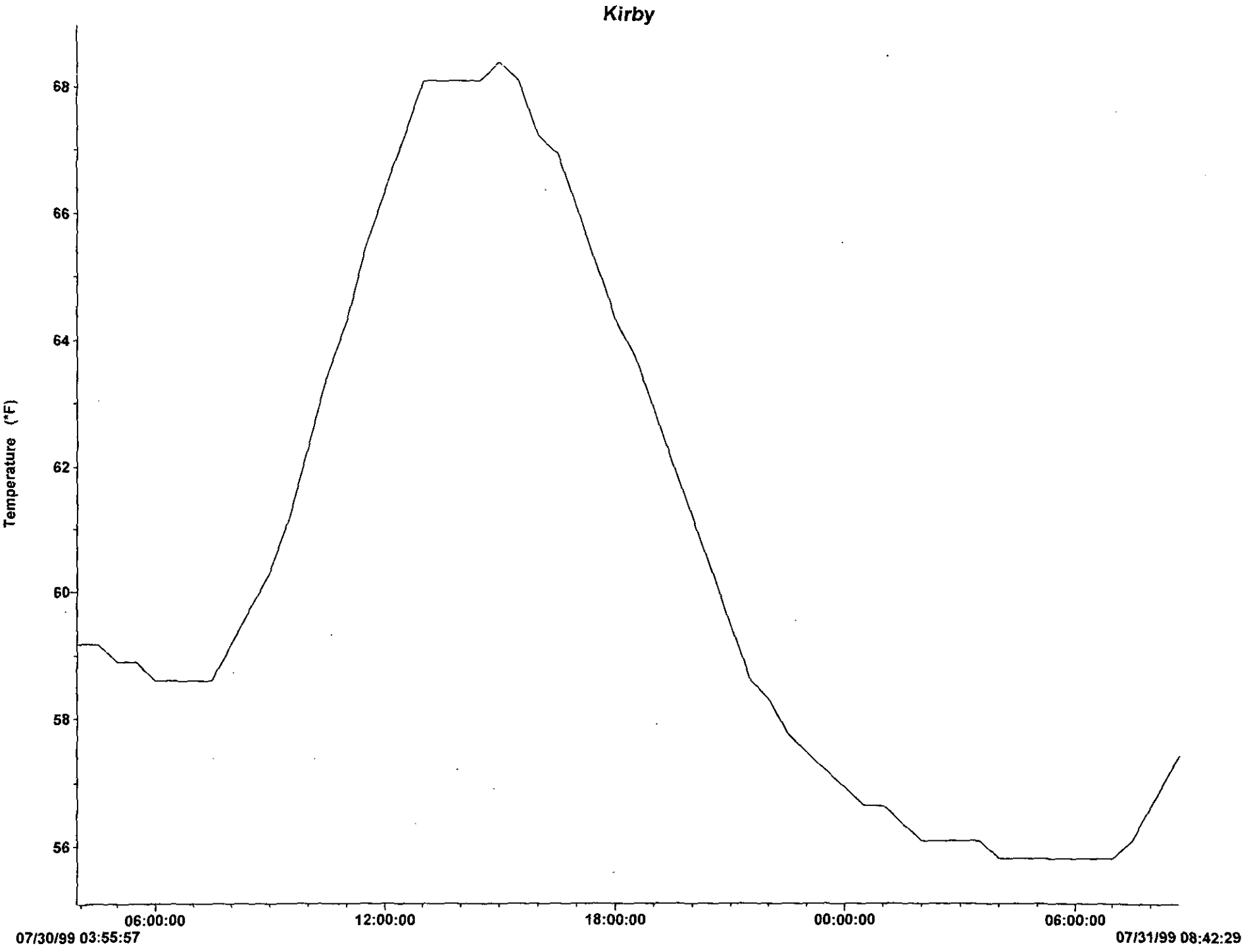
Diel water temperature fluctuations during the warmest 24 hours at selected sites.

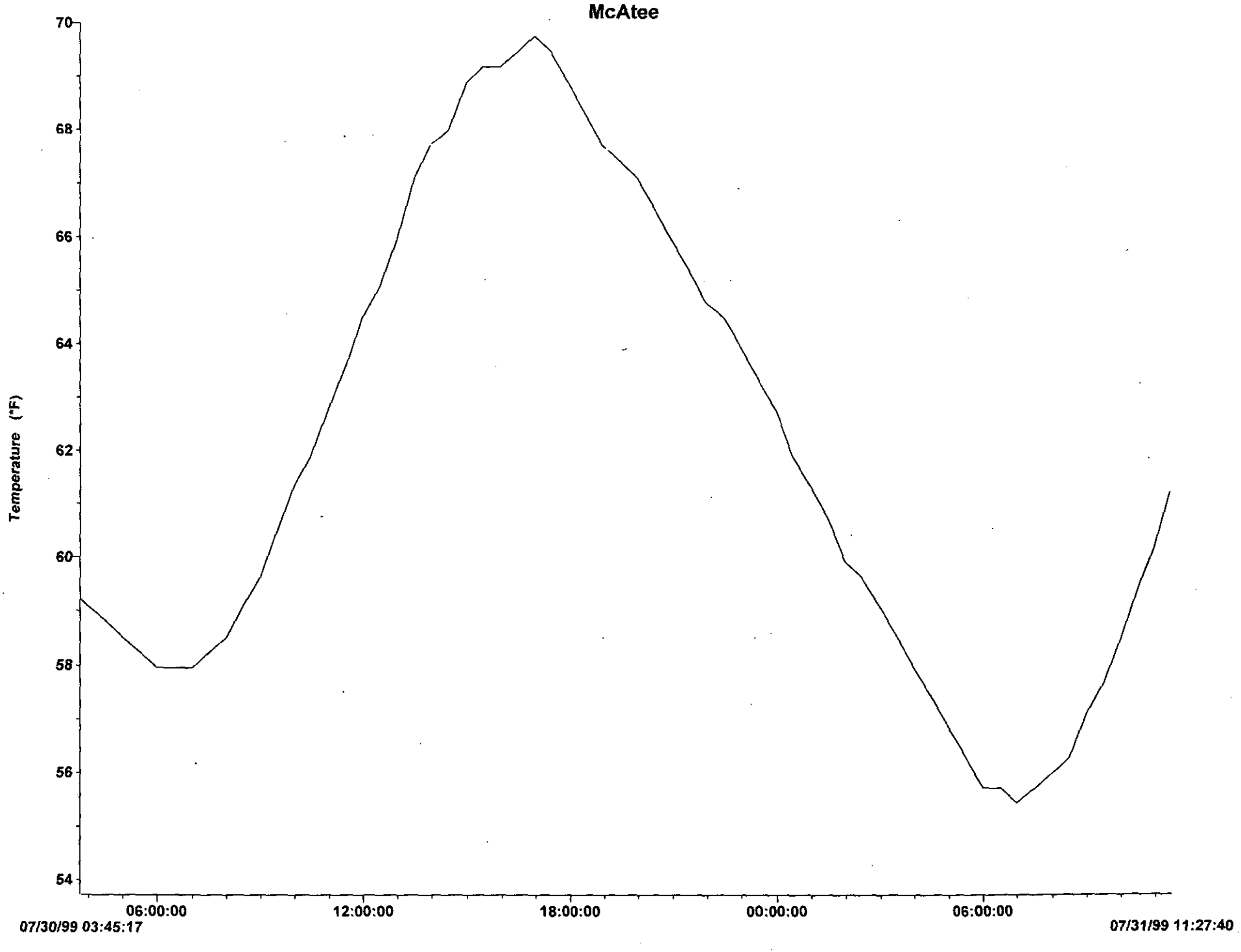

Hebgen inlet (hiway 191)
Temperature (°F)
72
70
68
66
64
62
07/13/99 00:30:13
12:00:00
00:00:00
12:00:00
07/14/99 12:45:42

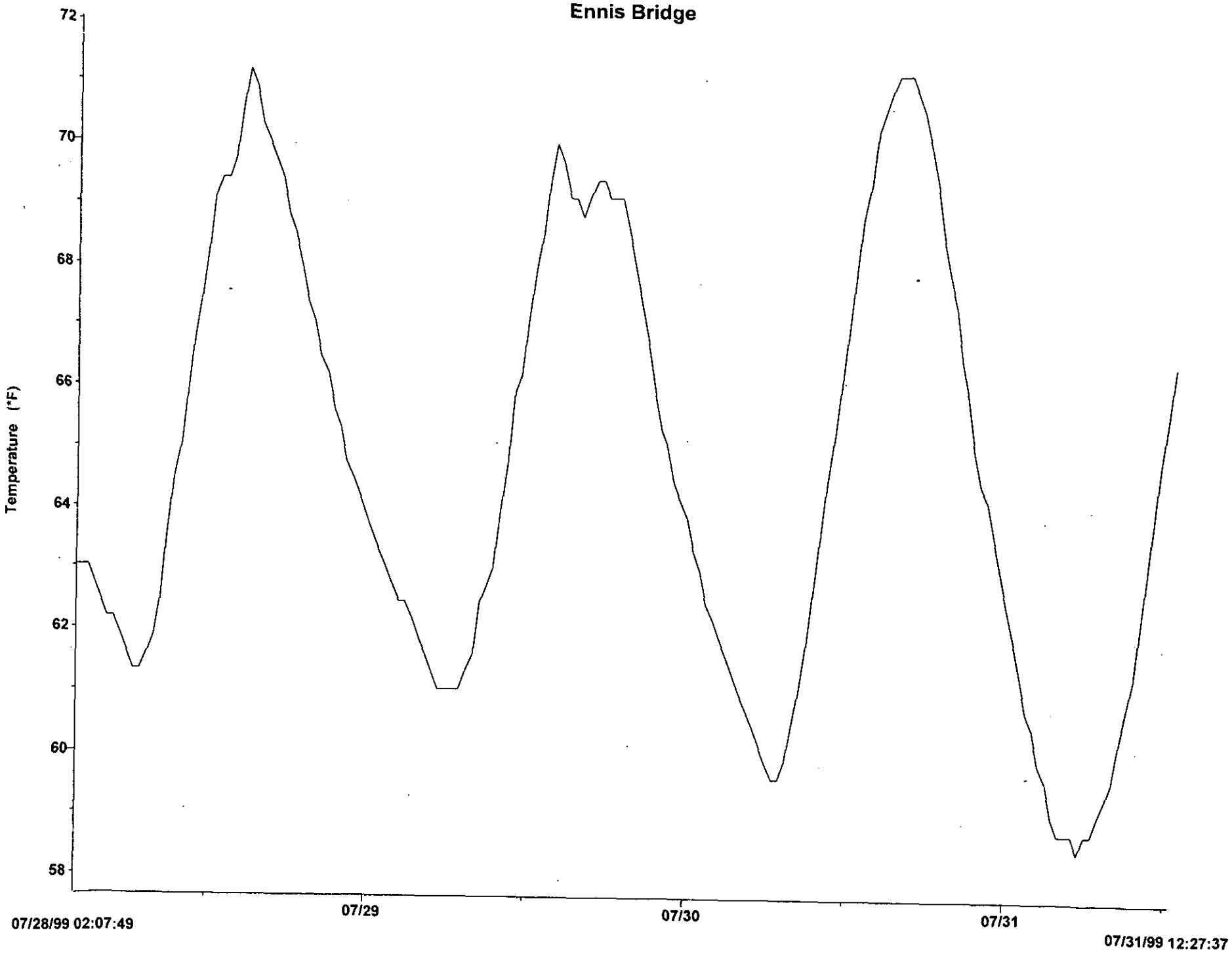

Hebgen discharge
66
65
64
63
62
61
Temperature (°F)
12:00:00
00:00:00
12:00:00
00:00:00
12:00:00
08/30/99 06:51:17
09/01/99 22:48:02

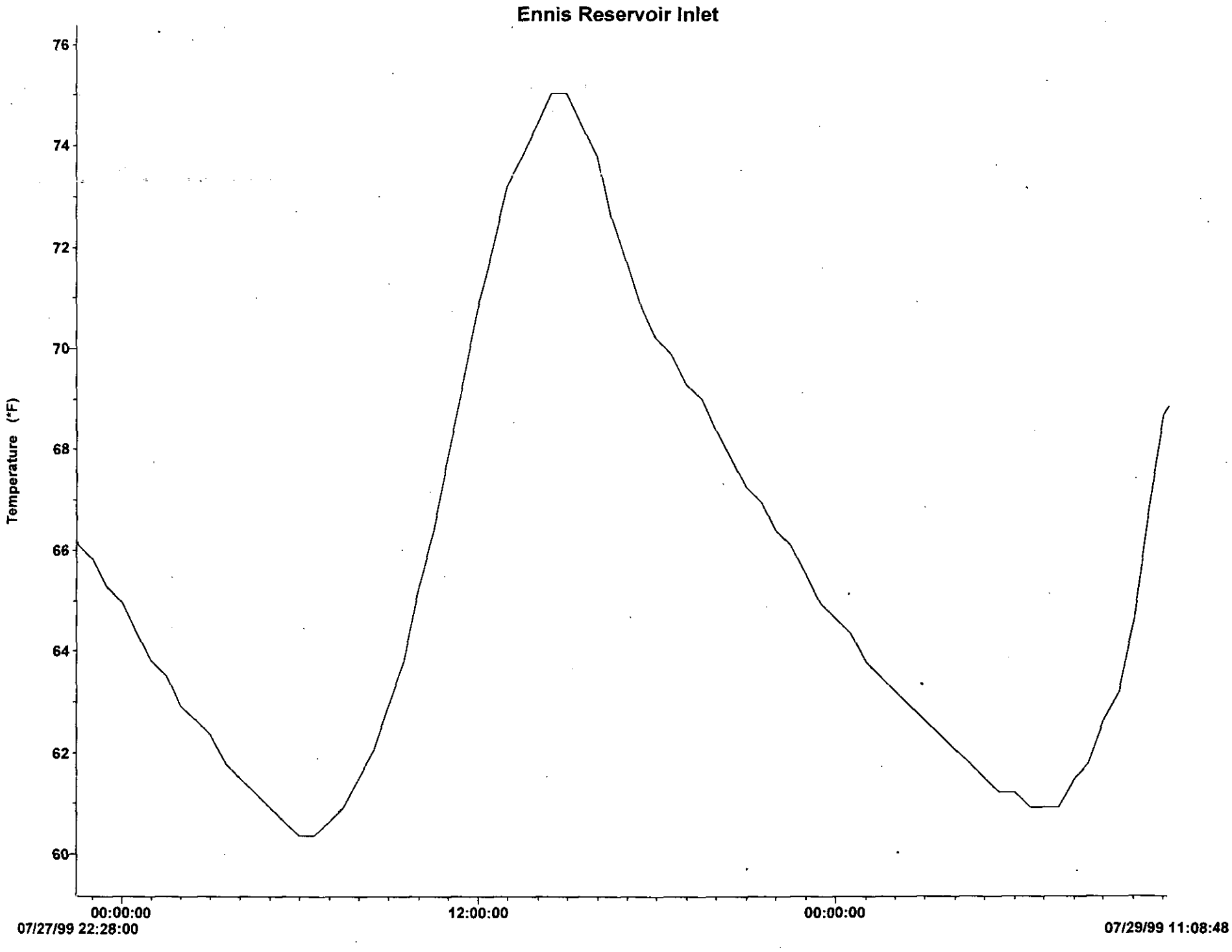

Hebgen-Quake river section
Temperature (°F)
65.5
65
64.5
64
63.5
63
62.5
62
61.5
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
08/31/99 00:55:42
09/01/99 11:20:37

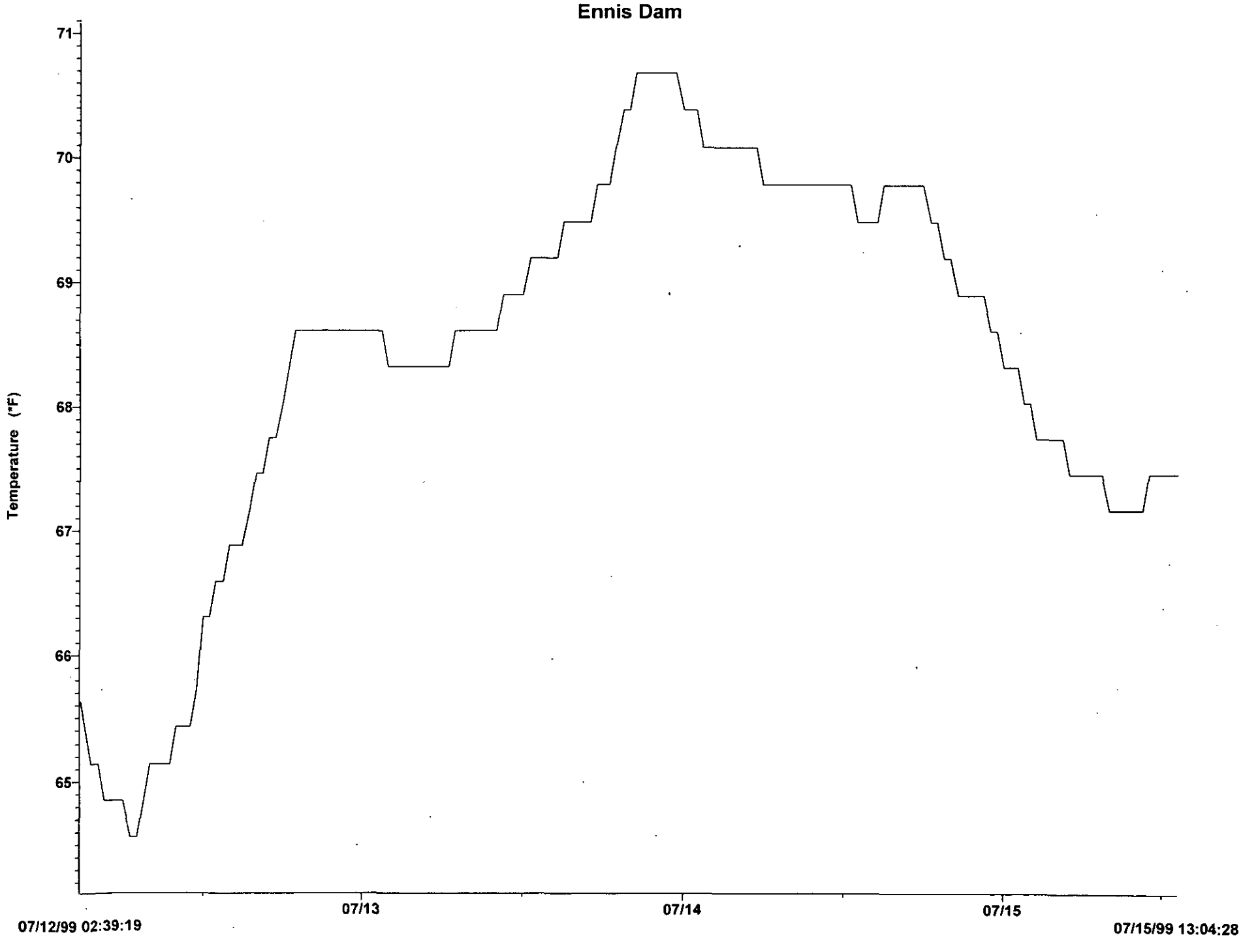

Quake outlet
Temperature (°F)
64
63.5
63
62.5
62
61.5
61
60.5
60
07/29/99 06:56:43
12:00:00
18:00:00
00:00:00
06:00:00
07/30/99 06:06:49

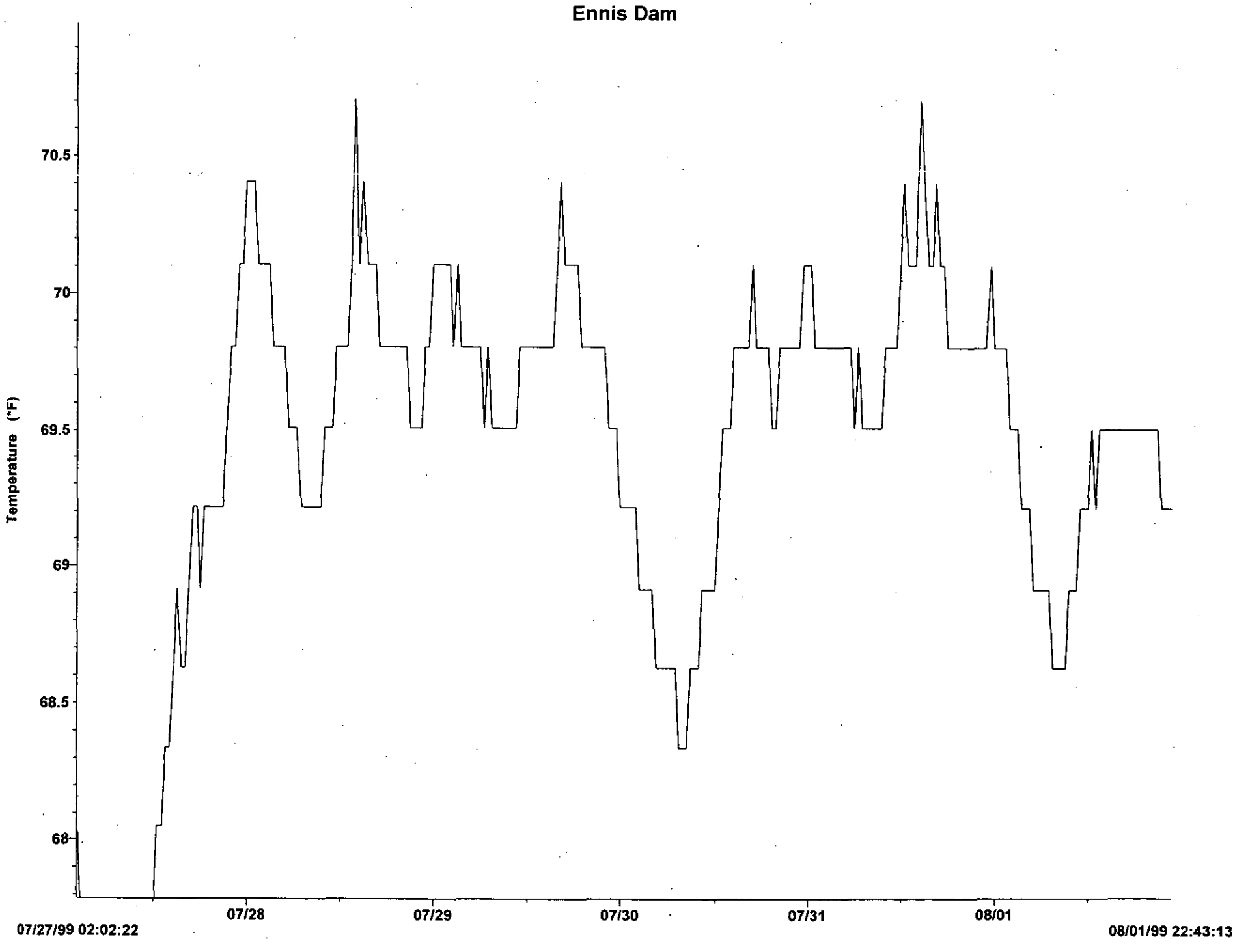

Kirby
Temperature (°F)
68
66
64
62
60
58
56
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
07/30/99 03:55:57
07/31/99 08:42:29

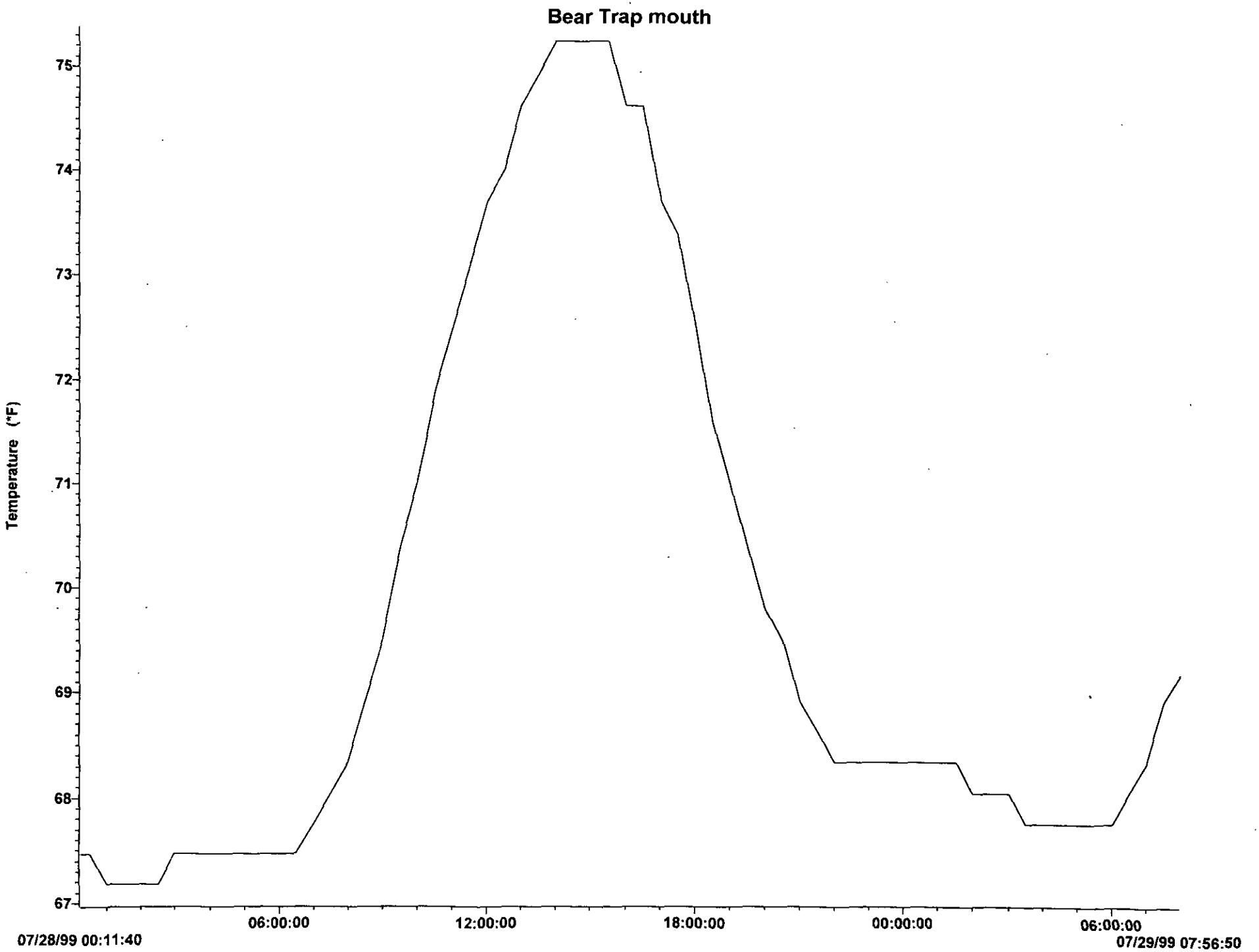

McAtee
70
68
66
64
62
60
58
56
54
Temperature (°F)
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
07/30/99 03:45:17
07/31/99 11:27:40

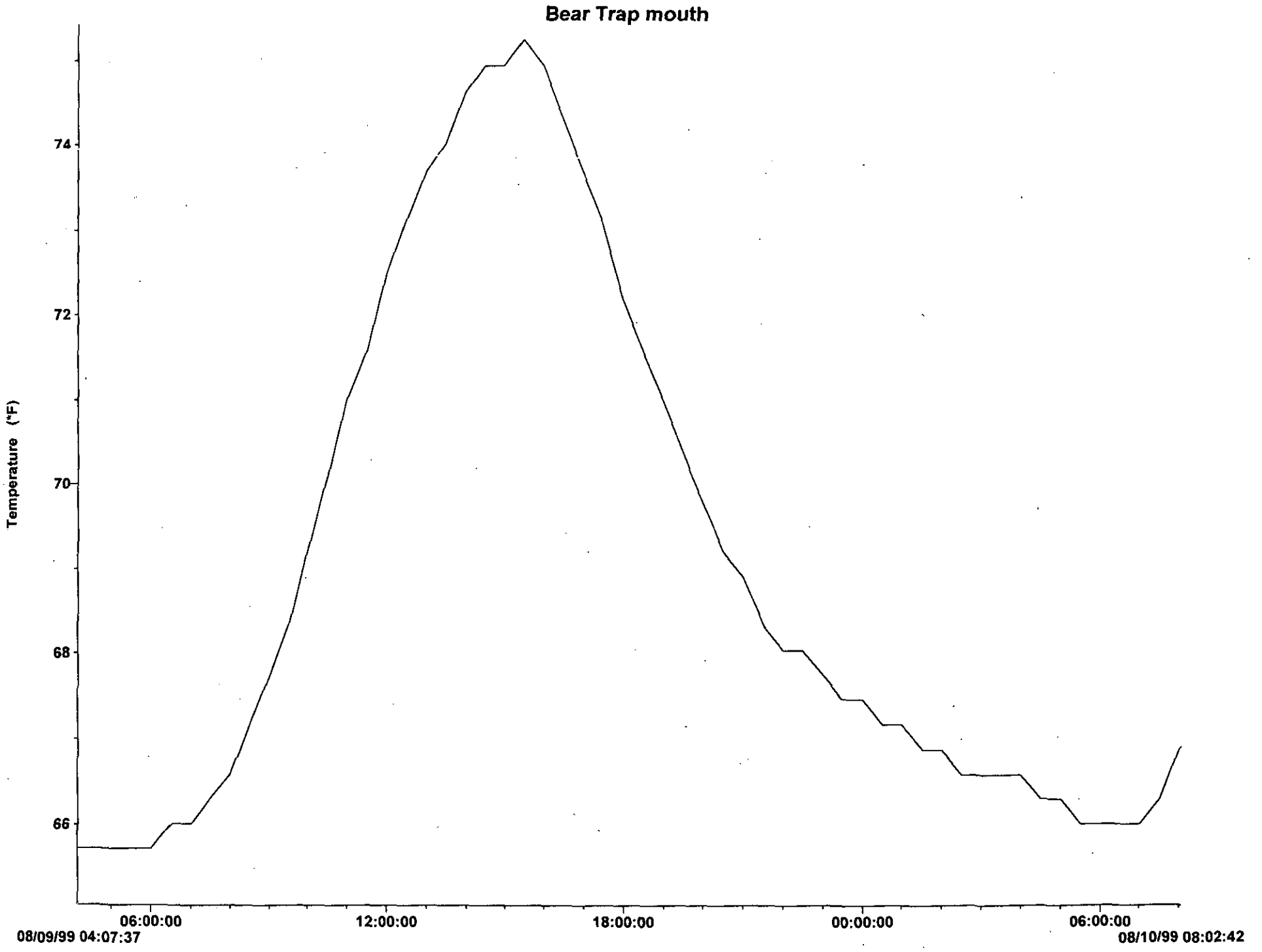

Ennis Bridge
72
70
68
66
64
62
60
58
Temperature (°F)
07/28/99 02:07:49
07/29
07/30
07/31
07/31/99 12:27:37

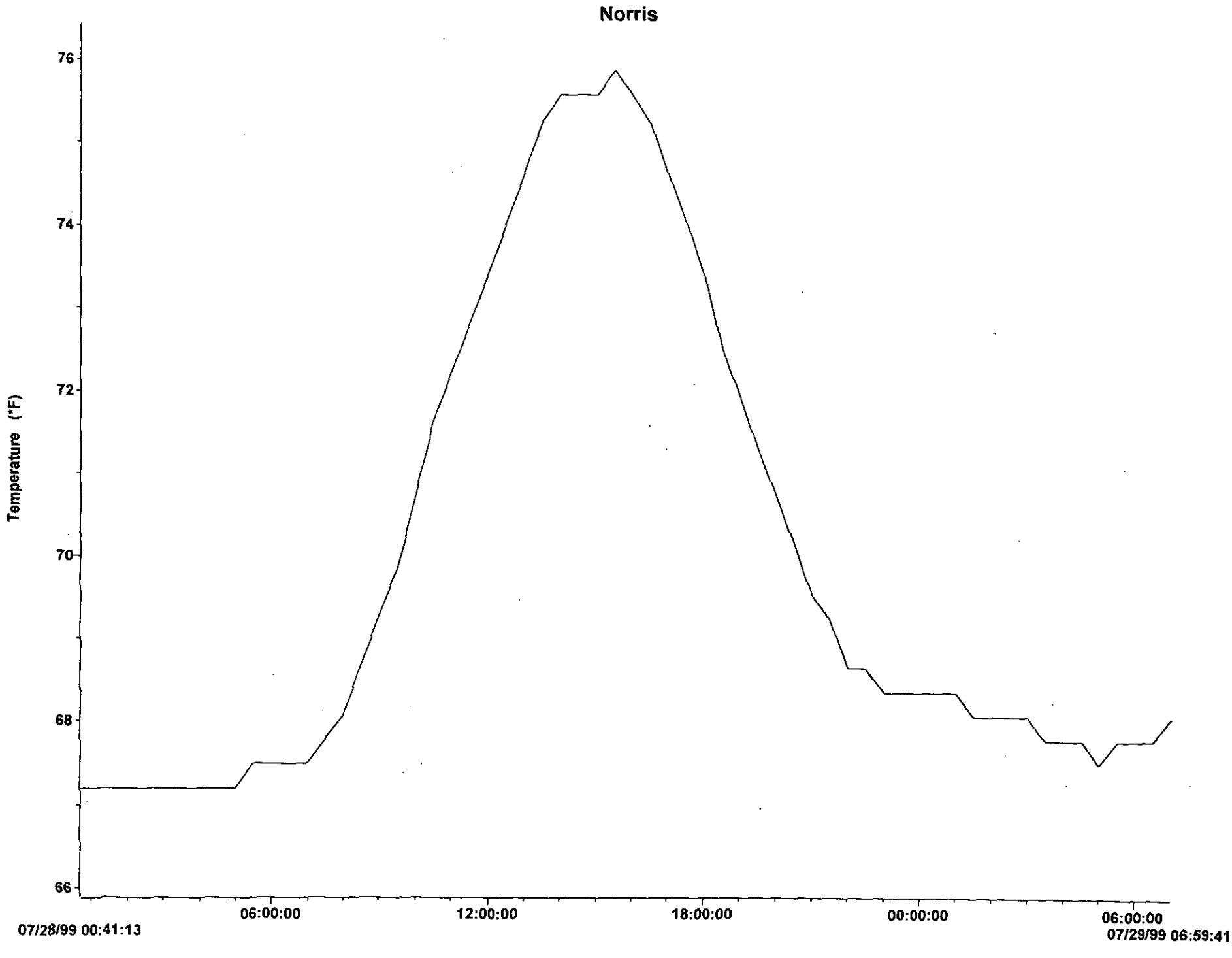

Ennis Reservoir Inlet
Temperature (°F)
76
74
72
70
68
66
64
62
60
00:00:00
07/27/99 22:28:00
12:00:00
00:00:00
07/29/99 11:08:48

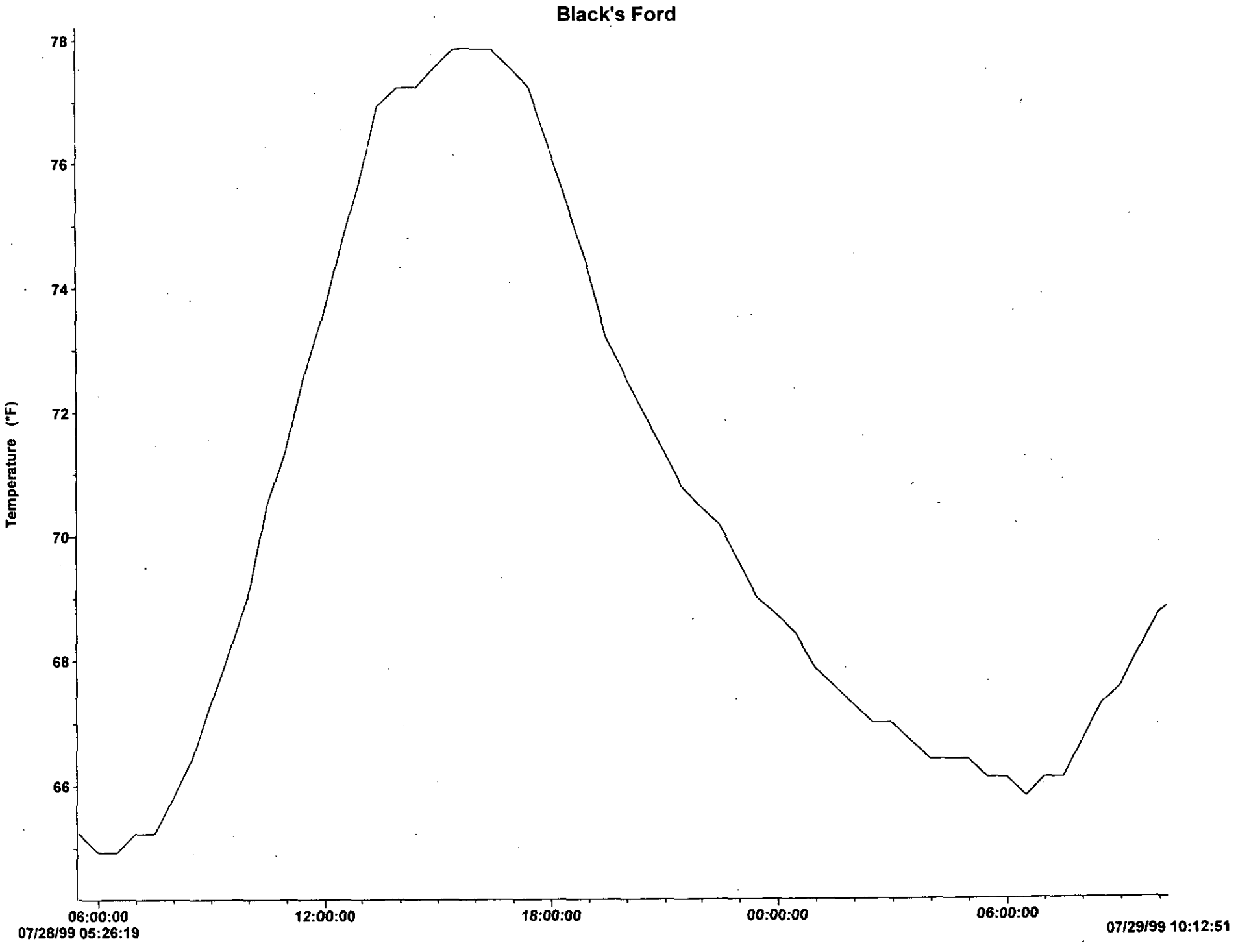

Ennis Dam
Temperature (°F)
71
70
69
68
67
66
65
07/12/99 02:39:19
07/13
07/14
07/15
07/15/99 13:04:28

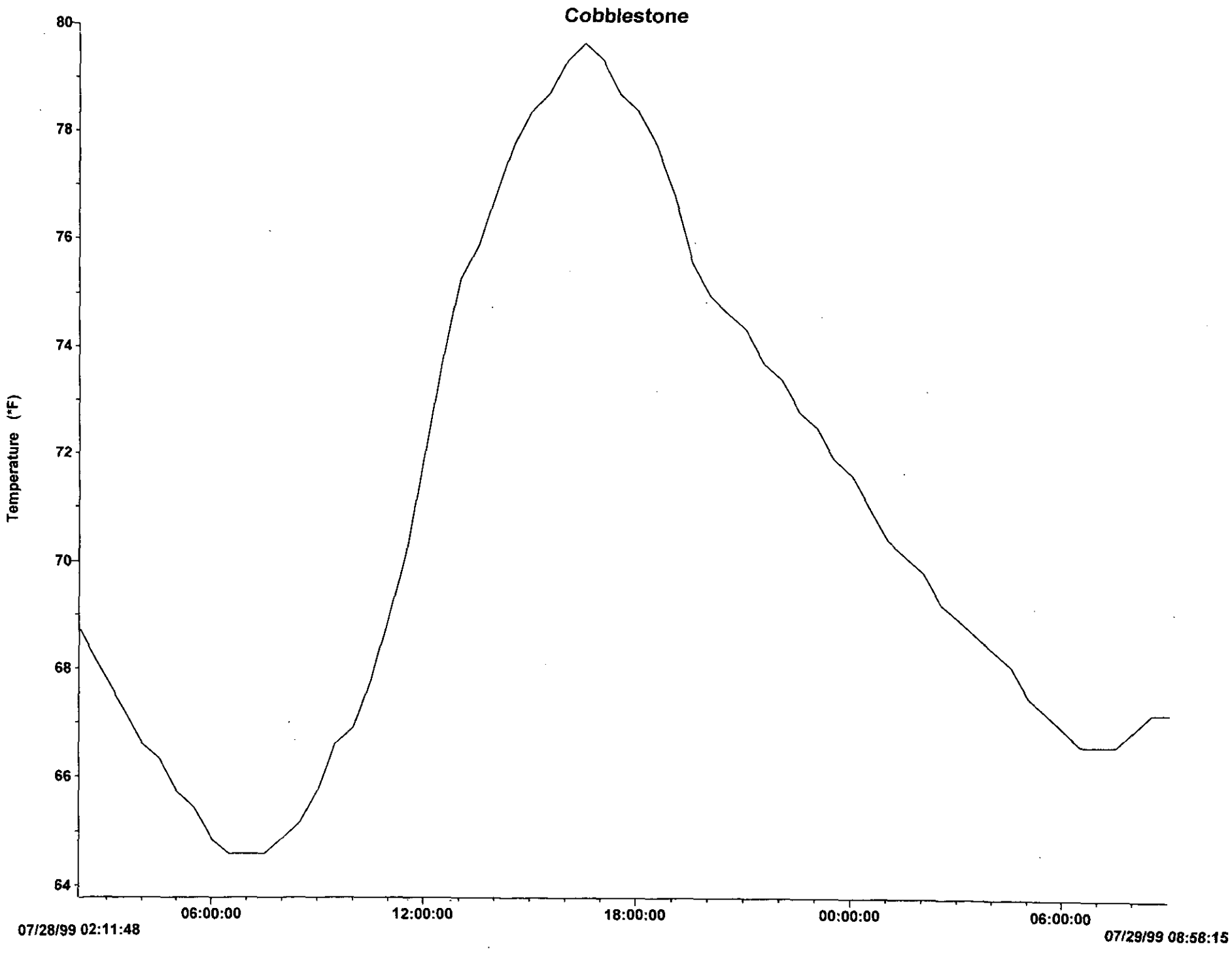

Ennis Dam
Temperature (°F)
70.5
70
69.5
69
68.5
68
07/28
07/29
07/30
07/31
08/01
07/27/99 02:02:22
08/01/99 22:43:13

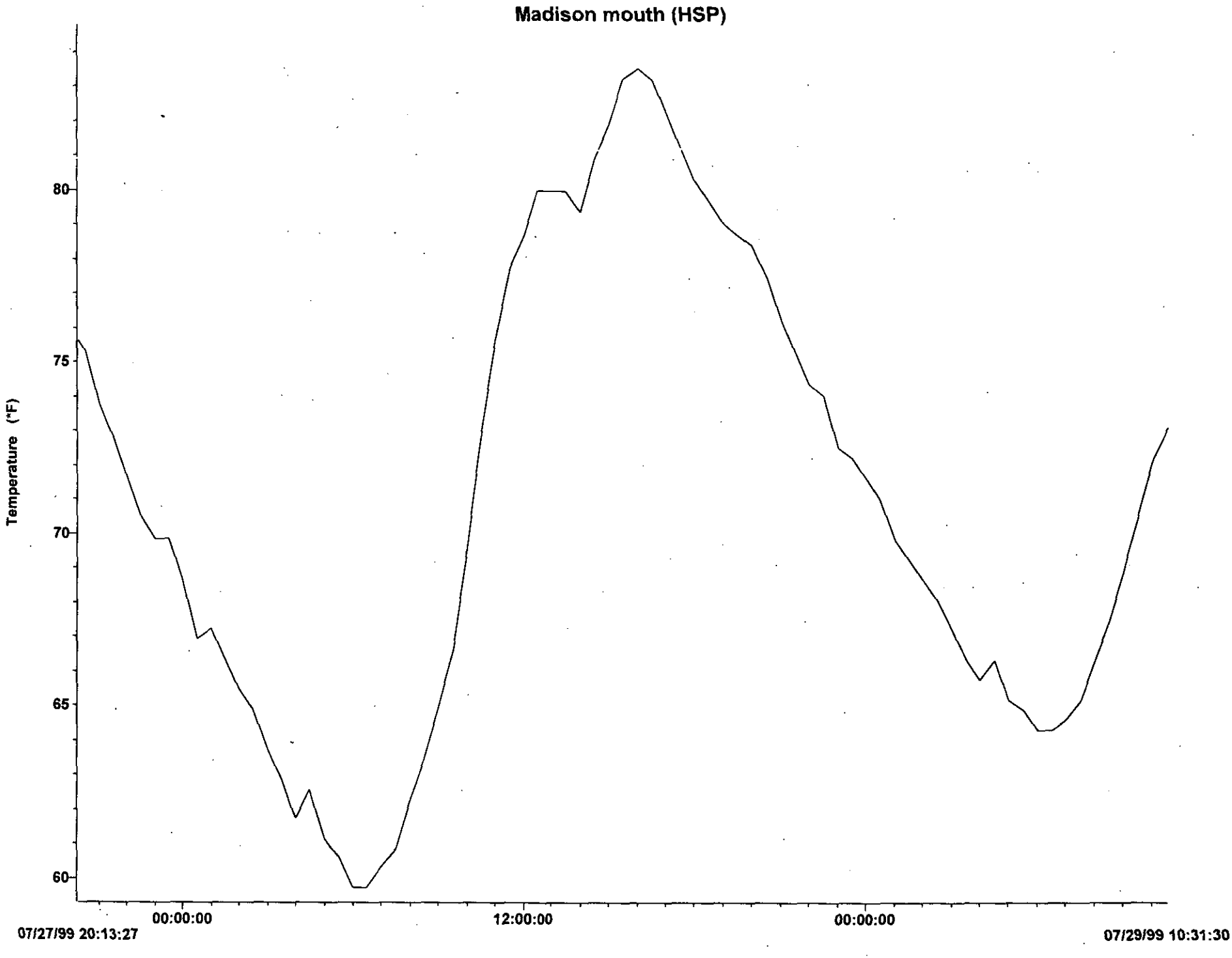

Bear Trap mouth
Temperature (°F)
75
74
73
72
71
70
69
68
67
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
07/28/99 00:11:40
07/29/99 07:56:50


Bear Trap mouth
Temperature (°F)
74
72
70
68
66
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
08/09/99 04:07:37
08/10/99 08:02:42


Norris
76
74
72
70
68
66
Temperature (°F)
07/28/99 00:41:13
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
07/29/99 06:59:41


Black's Ford
Temperature (°F)
78
76
74
72
70
68
66
06:00:00
07/28/99 05:26:19
12:00:00
18:00:00
00:00:00
06:00:00
07/29/99 10:12:51


Cobblestone
80
78
76
74
72
70
68
66
64
Temperature (°F)
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
07/28/99 02:11:48
07/29/99 08:58:15


Madison mouth (HSP)
Temperature (°F)
80
75
70
65
60
00:00:00
12:00:00
00:00:00
07/27/99 20:13:27
07/29/99 10:31:30