F-13-6

Madison River/Ennis Reservoir Fisheries

1994 Annual Report
to
Montana Power Company
Environmental Division
Butte

from
Montana Fish, Wildlife, & Parks
Pat Clancey
Ennis

May 1995

INTRODUCTION

In 1990, the Montana Power Company (MPC) and Montana Fish, Wildlife, and Parks (FWP) agreed to initiate fieldwork on the Madison River/Ennis Reservoir arctic grayling (Thymallus arcticus) population. MPC owns and operates Hebgen and Ennis (Madison) dams on the Madison River, and an additional seven dams on the Missouri River (Fig 1). This hydropower system is presently undergoing the Federal Energy Regulatory Commission (FERC) relicensing process. MPC's dams and resultant reservoir operations may affect fish populations in the rivers and reservoirs. The fluvial arctic grayling has been petitioned to be listed on the U.S. Fish and Wildlife Service's (USFWS) Threatened and Endangered Species List (Federal Register 1993). On July 25, 1994, the USFWS determined that listing was warranted, but precluded (Federal Register, 1994). The Big Hole River in southwestern Montana (Fig. 1) is currently thought to be the sole remaining location in the continuous United States with a population of fluvial arctic grayling. MPC and FWP agree that the Madison River population warrants study to determine whether it is fluvial, and to address the potential affects that listing the species could have on reservoir operations, river flows, and other fisheries and recreation issues, while working to maintain and increase the grayling population.

Additional fisheries issues are also being addressed on the Madison River. Some are reported in this document, some have been reported in previous submissions to MPC (Montana Fish, Wildlife, and Parks 1994a).

METHODS

The principal method of capturing adult Madison grayling was a driftboat mounted mobile anode electrofishing system used primarily during the spring spawning run. Secondary methods used in the Madison River channels area were trapping and hook-and-line. Sampling in Ennis Reservoir was conducted using jetboat mounted boom electrofishing in and around the mouths of the channels of the Madison River as they enter Ennis Reservoir, gill and trammel netting, and beach and purse seining.

Captured fish were weighed, measured, sexed, tagged behind one or both eyes with individually numbered Visual Implant (V.I.)

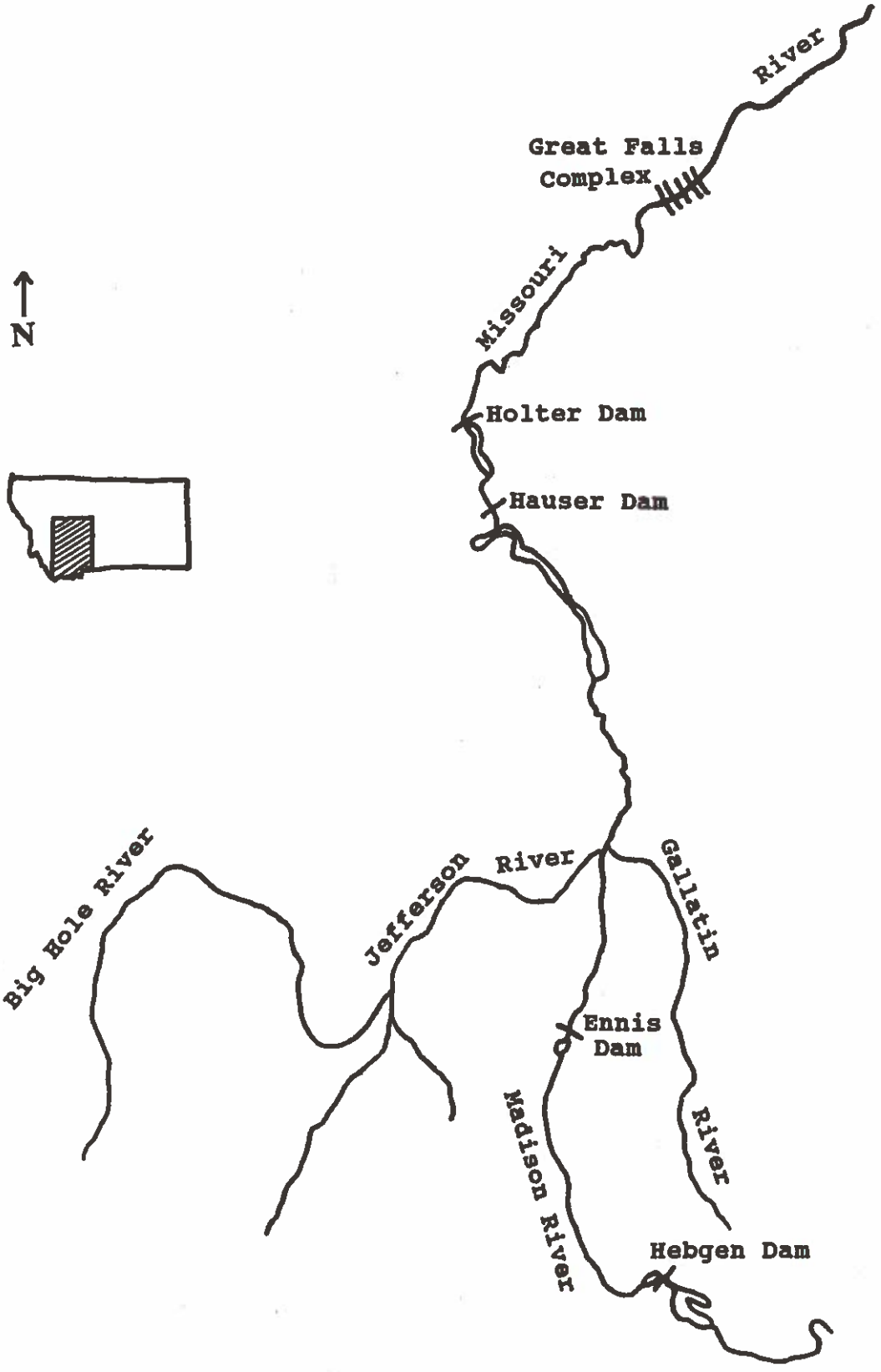

Figure 1. Madison/Missouri River system.

tags, and released.

Estimates of the spawning population of Madison grayling have been conducted by Byorth and Shepard (1990), and in this report. The modified Petersen equation is used for the estimates:

. $N=([(M+1)(C+1)]/(R+1))-1$

$V_N=N^2(C-R)/[(C+1)(R-2)]$

where N= estimated population number
M= number of fish marked in the marking run
C= number of fish captured (marked + unmarked) in the capture run
R= number of marked fish in the capture run
V= Variance of N

To conduct the estimate, grayling captured in the spawning run one year serve as the marked population, and grayling captured in the spawning run the next year serve as the capture population. It is necessary to remove 2 year old fish from the capture population, since, as 1 year olds, they were not available to be marked in the first years spawning run.

During 1993 and 1994, eggs were stripped from females, fertilized with sperm pooled from males, and sent to the Bozeman Fish Technology Center, or other selected hatcheries, for rearing. The resulting fry were used for behavioral comparisons with progeny of known fluvial and lacustrine populations, and, in attempts to expand the range of the grayling, for introduction into streams deemed suitable for fluvial grayling.

Personnel from the Montana State University (MSU) Biology Department conducted the juvenile grayling studies through a graduate program (Kaya and Jeanes 1994). These studies were conducted to describe behavior and habits of juvenile grayling and to help address the question of the fluvial nature of the Madison grayling population. Consultants retained by MPC participated in joint field efforts and conducted snorkel surveys in the reservoir for juvenile grayling (R2 Resource Consultants, Inc. 1994).

Each spring and fall, FWP uses the mobile anode electrofishing method to conduct trout population estimates throughout the Madison River. A log-liklihood statistical analysis is used to estimate trout populations (Montana Fish, Wildlife, Parks 1994b). Estimates historically were conducted by the FWP area biologist and technicians in various sections of the river (Fig. 2). Beginning in the fall of 1992, the P,M,& E biologist began participating in the estimates. The involvement of the P,M,& E biologist is justified by the recognition that MPC hydropower operations directly affect the well-being of trout populations. In March, 1994, an estimate was conducted in the Bypass section. This is the first concerted effort by FWP to assess trout populations in the Bypass.

In the past, FWP has not prioritized the "bypass" reach of the Madison River for fisheries work. Since 1992, under the agreement with MPC, work has begun in this area to assess fisheries. Trapping, electrofishing, and other work has been conducted periodically by personnel of MPC, FWP, and MPC-retained consultants (R2 Resource Consultants 1993a, 1993b). Additional work will be conducted by FWP as the P,M,& E program develops.

High water temperatures are blamed for two fish kills that began in the Black's Ford area of the river in 1988. To develop a model to predict thermal conditions at any point in the lower Madison River (Jourdonnais et al. 1992), MPC used Omnidata Datapod units to collect water temperatures data since 1989 from various locations in the Madison River, and FWP water temperature data that has been collected from the lower Madison since 1972. In July, 1994, FWP placed StowAway temperature loggers at 10 sites between Ennis and Greycliff (Fig 3.). Each unit was programmed to record temperature every 30 minutes. Temperature data was downloaded in the field and the logger reset. The loggers were removed from the river in mid-October. These temperature loggers will be used to supplement other thermal data being collected by MPC and FWP.

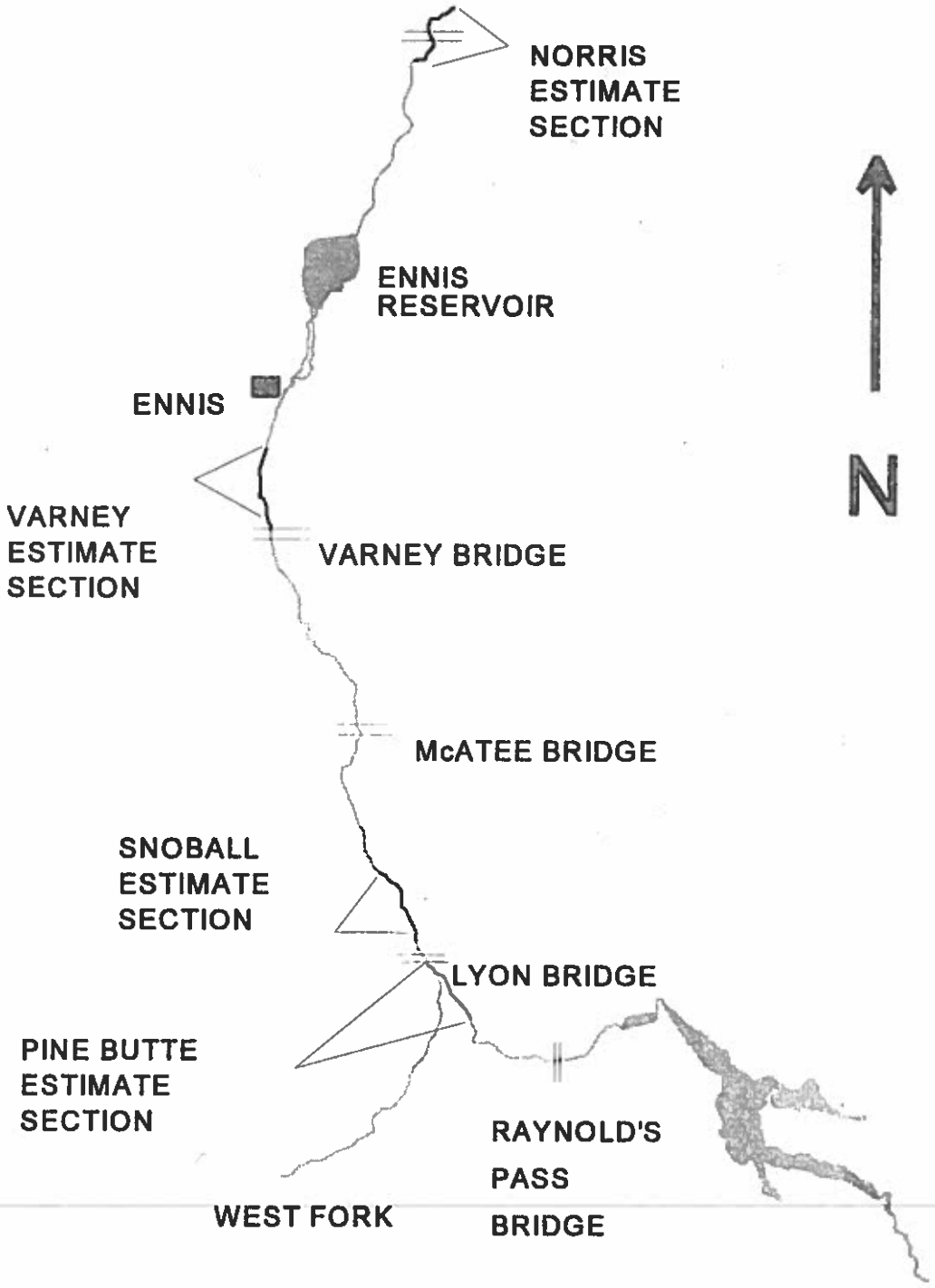

Figure 2. Madison River population estimate sections.

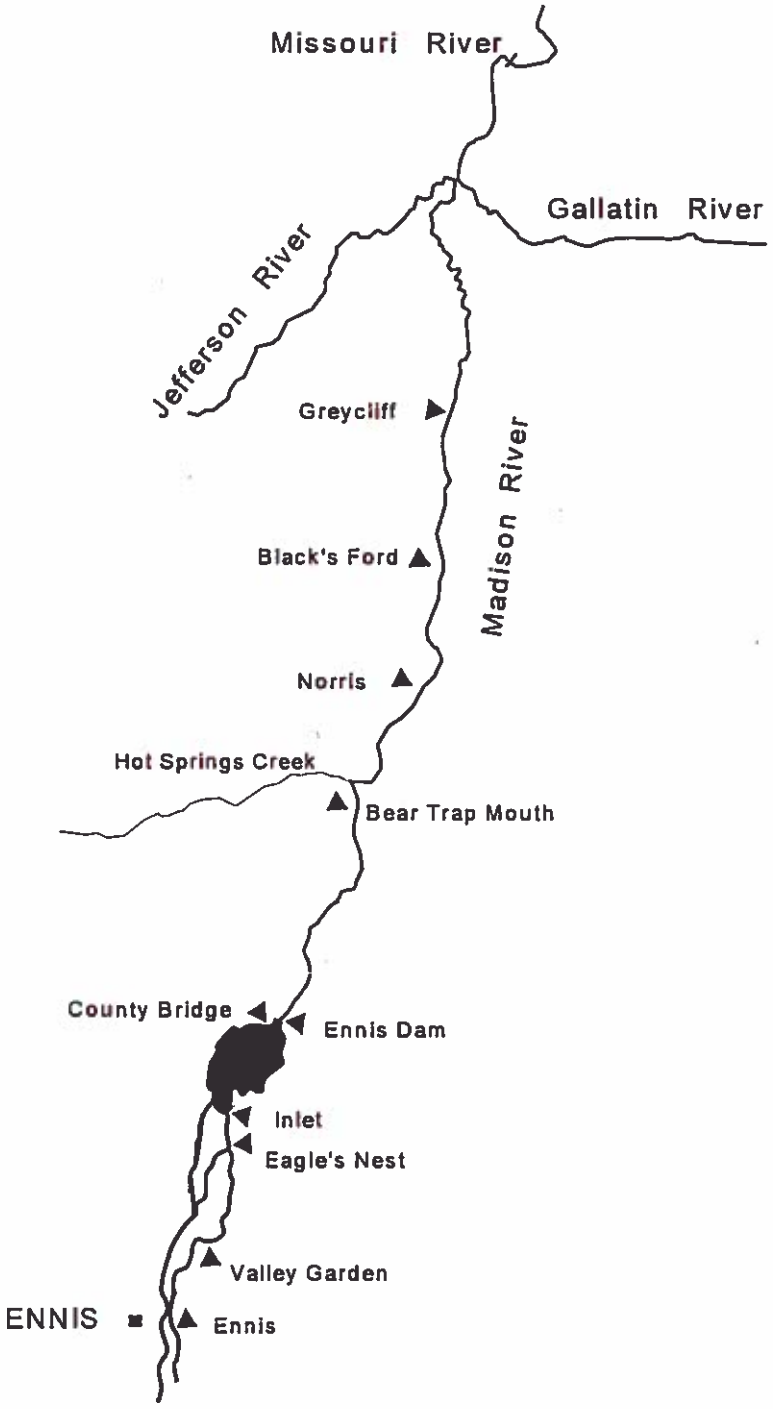

Figure 3. Locations of StowAway temperature loggers, Madison River, 1994.

RESULTS AND DISCUSSION

Madison Grayling

The 1994 grayling spawning run apparently began suddenly and ended abruptly. As in previous years, grayling spawned in the few miles of river between Valley Garden Fishing Access Site and Ennis Reservoir, mostly in the 1 1/2 miles just above the reservoir (Figure 4). Figure 5 illustrates the temporal distribution of the spawning run each year since 1990. Recaptures of spawning grayling (Table 1) within any particular year show that they readily move between various areas of the Channels section of the Madison River. Because of this propensity to move about, grayling may occupy a specific channel one day, but not the next. So, depending on the specific route taken during any particular day's electrofishing, few grayling may be captured, even at the height of the run. Conversely, a relatively high number may be caught despite the apparent small size of the population. Byorth and Shepard (1990) calculated a population size of 545 fish larger than 10 inches, but recognized the limitations of conducting an estimate on a small population. A population size of 996 ±423 (80 % confidence limits) was calculated for the 1992 spawning population. The estimate for the 1993 spawning population is 619 ±290 (80 % C.I.). There are obvious shortcomings to this population estimation procedure. The one year time lag necessary to collect the capture population may preclude detecting any potential problems within the population. Additionally, the "tightness" of the estimate is questionable because it is subject to such large variation in either the marked population or the capture population. The 1993 estimate is poor, and the 1994 can be expected to be poor, due to the extremely small number of grayling captured in 1994, only 29 fish. Daily monitoring is required to detect the initiation of the run. The manpower available to work the run is not consistent, either in availability or experience. It is for reasons such as these that trapping will be used in an attempt to increase efficiency in capturing spawners in the 1995 run.

Age structure of spawning grayling is outlined in Table 2. Grayling captured in 1991 that were larger than 13.8 inches were not aged due to misplacement of their scale card. In 1992 and 1993, when spawning runs were relatively strong, age 2 fish were

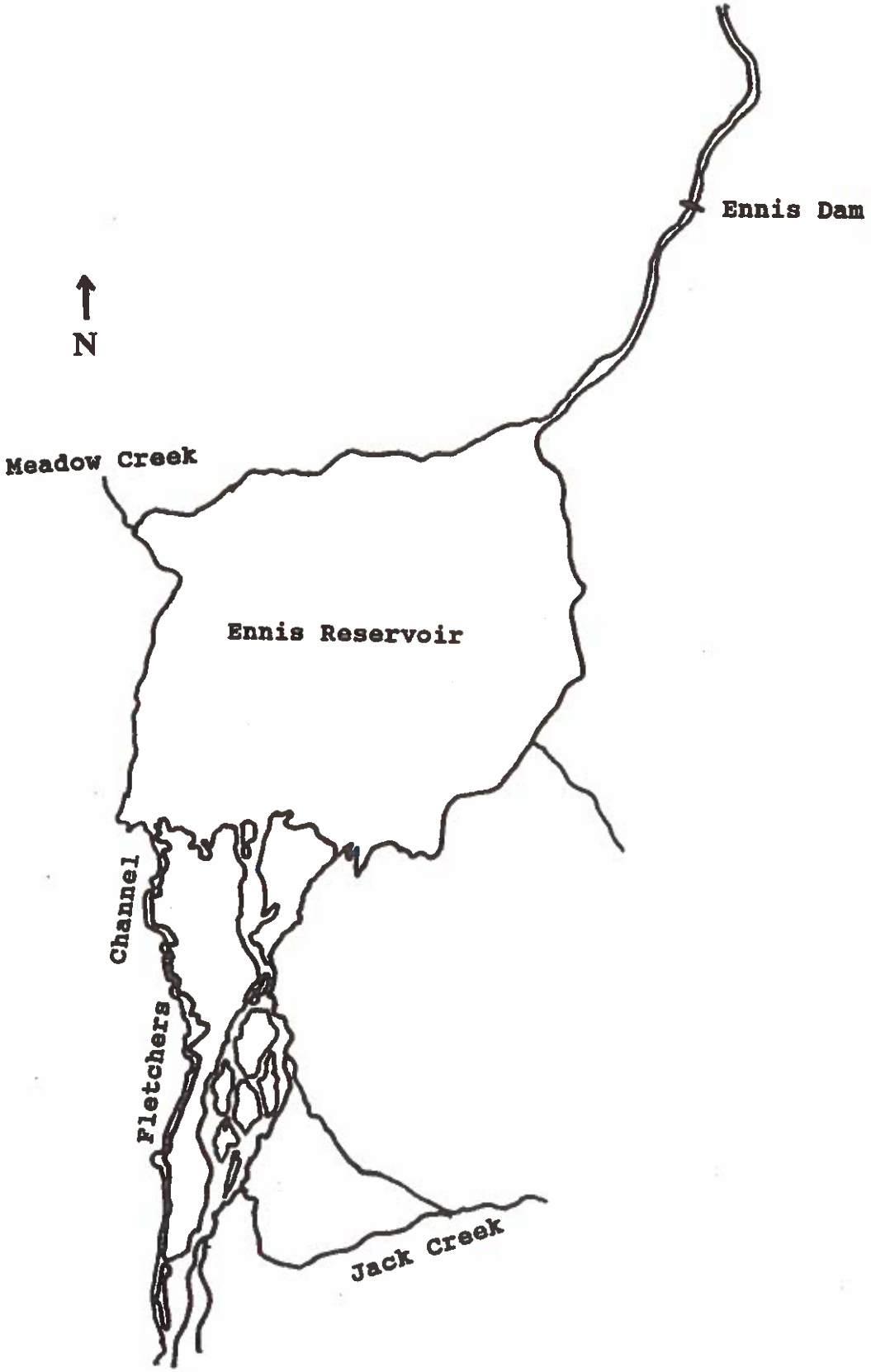

Figure 4. Madison River Channels section and Ennis Reservoir.

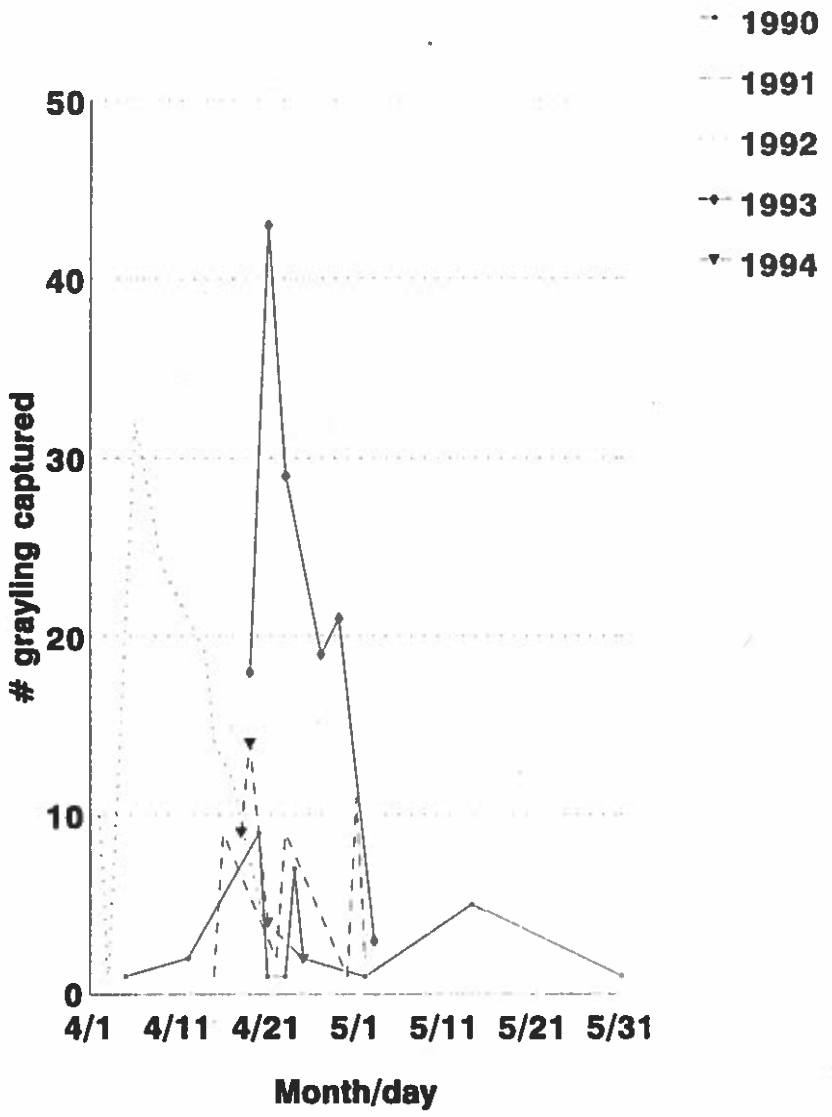

Figure 5. Temporal distribution of Madison grayling spawning run, 1990-1994.

Table 1. Recaptures of tagged grayling in the Madison drainage, 1990-94. Any recaptures made within the same calender year as the tagging date are not reported.

Tag date	location	length	weight	sex	Recapture date	length	weight	location
1991								
5/1	Channels	12.6"	0.581bs.	M	4/24/93	15.0"	1.0	Channels
1992								
4/2	Channels	12.8	0.65	M	4/21/93	14.3	0.88	Channels
4/6	Channels	12.6	0.66	F	4/29/93	14.7	0.98	Channels
	"	14.8	1.08	M	5/3/93	--	--	Fletchers
	"	15.1	1.00	M	4/19/93	16.1	1.18	Channels
	"	12.6	0.66	M	4/18/94	15.6	1.22	Channels
4/9	Channels	11.5	0.46	F	4/21/93	13.1	0.80	Channels
4/14	Channels	11.4	0.53	M	4/19/93	12.8	0.80	Channels
4/15	Fletchers	15.3	1.08	F	4/19/94	15.9	1.10	Fletchers
1993								
4/19	Channels	13.9	0.80	M	4/21/94	15.2	1.01	Channels
4/21	Channels	14.2	0.81	M	4/21/94	15.2	0.99	Channels
4/23	Fletchers	11.2	0.50	F	3/14/94	12.2	0.62	Bypass
4/27	Channels	12.7	0.60	M	4/19/94	14.5	0.80	Fletchers
	"	11.7	0.56	M	9/30/94	~16[1]	--	Reservr.

[1]Angler report

Table 2. Age structure and average length of grayling captured in the spawning run in the Channels section of the Madison River, 1990-94.

	1990			1991		1992		
	M	F	U	M	F	M	F	U
Age								
I			7.2 n=3 (6.6-7.7)					7.6 n=2 (7.2-8.0)
II	14.6 n=2 (14.6& 14.6)	11.9 n=1		12.4 n=14 (11.5-12.8)	12.5 n=2 (12.2-12.8)	12.4 n=43 (11.8-13.3)	12.1 n=13 (10.4-13.5)	
III	15.0 n=9 (14.2-15.6)	14.3 n=4 (13.6-14.9)	14.7 n=4 (14.2-15.1)	13.8 n=1	--- n=0	14.2 n=36 (11.2-15.9)	14.3 n=14 (13.7-15.7)	

Table 2 (continued).

	1993		1994	
	M	F	M	F
Age				
I	0	0	0	0
II	12.1 n=48 (11.0- 13.2)	11.3 n=19 (10.2- 12.1)	11.9 n=5 (11.5- 12.1)	-- n=0
III	13.7 n=31 (11.0- 15.8)	13.5 n=16 (11.4- 14.9)	14.4 n=10 (13.8- 14.8)	13.6 n=4 (13.5- 13.8)
IV	15.1 n=5 (13.2- 16.1)	14.6 n=4 (13.8- 15.9)	15.4 n=6 (14.6- 15.9)	15.4 n=1
V				16.2 n=1

the strongest cohort. In 1990, when the run was weak, age 3 fish were the strongest cohort. This may have also been the case in 1991, but cannot be confirmed due to the loss of the scale card. Table 3 contains the backcalculated length-at-age data for various aged fish in each annual spawning run. The small sample size obtained in some years precludes definitive conclusions regarding growth. Generally, the only recognizable growth pattern is the noticable decrease in annual growth of both sexes after age 2.

Table 3. Length-at-age (backcalculation) of grayling captured during the spawning run, 1990-94.

	M	F	U
1990			
I			
@I			7.2
n=3			(6.6-7.7)
II			
@I	8.0	6.0	
	n=2	n=1	
	(8.0 & 8.0)		
@II	14.6	11.9	
	(14.6 & 14.6)		
III			
@I	6.4	5.4	6.9
	n=9	n=4	n=4
	(5.3-7.7)	(4.4-6.4)	(5.6-7.9)
@II	12.4	12.0	13.0
	(11.5-13.1)	(10.1-13.1)	(12.1-13.8)
@III	15.0	14.3	14.7
	(14.2-15.6)	(13.6-14.9)	(14.2-15.1)
1991			
II			
@I	5.8	6.3	
	n=14	n=2	
	(4.9-6.9)	(5.6-6.9)	
@II	12.4	12.5	
	(11.5-12.8)	(12.2-12.8)	
III			
@I	6.6		
	n=1		

Table 3 (continued).

@II	12.4		
@III	13.8		
1992			
I			
@I			7.6 n=2 (7.2-8.0)
II			
@I	6.5 n=43 (4.9-7.3)	6.6 n=13 (4.4-7.6)	
@II	12.4 (11.8-13.3)	12.1 (10.4-13.5)	
III			
@I	5.8 n=36 (4.2-7.8)	6.1 n=14 (5.2-7.0)	
@II	12.2 (8.7-14.2)	12.3 (11.6-14.1)	
@III	14.2 (11.2-15.9)	14.3 (13.7-15.7)	
1993			
II			
@I	6.3 n=48 (4.8-7.7)	6.3 n=19 (5.4-6.7)	
@II	12.1 (11.0-13.2)	11.3 (10.2-12.1)	

Table 3 (continued).

III		
@I	6.3 n=31 (5.3-8.0)	6.1 n=16 (5.3-7.2)
@II	12.2 (9.8-13.7)	11.8 (10.4-12.9)
@III	13.7 (11.0-15.8)	13.5 (11.4-14.9)
IV		
@I	5.6 n=5 (4.5-6.1)	5.4 n=4 (4.7-5.8)
@II	12.3 (10.6-13.1)	11.6 (10.6-12.7)
@III	14.1 (12.1-15.3)	13.5 (13.0-14.2)
@IV	15.1 (13.2-16.1)	14.6 (13.8-15.9)
<u>1994</u>		
II		
@I	5.6 n=5 (5.0-5.9)	
@II	11.9 (11.5-12.1)	
III		
@I	6.2 n=10 (5.2-6.6)	5.9 n=4 (5.3-6.6)

Table 3 (continued).

@II	12.1 (10.3-14.3)	11.7 (11.2-11.9)
@III	14.4 (13.8-14.8)	13.6 (13.5-13.8)
IV		
@I	6.2 n=6 (5.5-7.3)	6.5 n=1
@II	12.4 (11.8-12.9)	12.8
@III	14.5 (14.2-15.0)	14.4
@IV	15.4 (14.6-15.9)	15.4
V		
@I		5.4 n=1
@II		11.9
@III		14.7
@IV		15.6
@V		16.2

Hundreds of suckers and some trout, but no grayling, were captured in an upstream trap installed in a channel of the Madison River in 1994. Construction of the trap was not completed until near the end of the grayling spawning run, therefore, it was not placed in the river until after the run was over. It was very efficient in capturing white suckers (Catostomus commersoni) during their spawning run. Additionally, rainbow trout (Oncorhynchus mykiss), brown trout (Salmo trutta), and longnosed suckers (Catostomus catostomus) were captured.

Angler interviews by Byorth and Shepard (1990), and recent conversations with anglers, revealed that grayling are readily caught in and around the inlets of Ennis Reservoir. Hook and line sampling was effective in capturing adult grayling at the mouth of Fletchers Channel in July, 1993. Of the 10 grayling captured, four were implanted with radio transmitters using the shielded-needle technique described by Ross and Kleiner (1982). Three days after implanting the transmitters could not be relocated. Subsequent attempts to locate the transmitters were also unsuccessful. The fate of these fish is unknown. Failure to relocate any of them may have been due to a variety of causes, including tag failure, raptor predation, or movement of the fish into Bear Trap Canyon. Grayling tagged with V.I. tags in Ennis Reservoir or the Channels section of the river have been captured in or below the Bypass reach of the river. However, it is most likely that these grayling were not relocated due to the inability to thoroughly search the reservoir and river because of the lack of appropriate watercraft and the expense required to hire an aircraft to conduct an aerial survey.

Appendix Figure 1 depicts the length-frequency, by sex, of grayling captured during spring electrofishing each year since 1990. Males outnumber females each year. The sex ratio has varied from 2.2:1 in 1990 & 1993 to 3.8:1 in 1994 (Table 4).

Results of the behavioral comparisons conducted with juvenile grayling are reported by Kaya and Jeanes (1994). This report was included in MPC's December, 1994, response to FERC's Additional Information Request. Initial intentions to reduce the density of rainbow and brook trout in the Butler reach of Cherry Creek in June, 1994, were thwarted by rain and high water. The effort was completed in July when approximately 1300 rainbow and 2200 brook trout were remove from the stream by electrofishing,

Table 4. Sex ratio (m:f) of spawning grayling captured by electrofishing in the Channels section of the Madison River, 1990-94.

Year/date	males	females	unknown	
1990				
4/5	0	0	1	
4/12	1	1		
4/18	0	0	1	
4/20	2	3	4	
4/21	1	0		
4/23	1	0		
4/24	4	1	1	
4/25	2	0		
Total	11	5	7	m:f= 2.2:1
1991				
4/15	1	0		
4/16	4	5		
4/22	1	1		
4/23	8	1		
4/30	1	0		
5/1	8	3		
5/2	2	0		
Total	25	10		m:f= 2.5:1
1992				
4/2	8	2		
4/3	0	1		
4/6	19	13		
4/9	19	4		
4/14	12	4		
4/15	10	2		
4/17	8	1	2	
4/21	3	0		
Total	79	27	2	m:f= 2.9:1

Table 4 (continued).

1993			
4/19	8	10	
4/21	26	15	
4/23	23	6	
4/27	14	4	
4/29	15	6	
5/3	3	0	
Total	89	41	m:f= 2.2:1
1994			
4/18	6	3	
4/19	11	3	
4/21	4	0	
4/25	2	0	
Total	23	6	m:f= 3.8:1

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and 1450 age 1 grayling were released into Cherry Creek. Eight hundred of the graylng were held for 48 hours in live cages before release, and 650 were released into Cherry Creek with no acclimation period. A downstream migrant trap was placed in Cherry Creek approximately 3-4 miles downstream of the introduction site from July 25 to August 29. No grayling, or any other fish, were captured. The landowner along the Butler reach reported catching and releasing grayling in September.

In the spring and summer of 1994, personnel from FWP and MSU spent much time locating and monitoring the rearing and growth of young-of-the-year (y-o-y) grayling in the Madison River channels area and in Ennis Reservoir (Kaya and Jeanes 1994). They found y-o-y grayling use small blind backchannels of the Madison River for rearing, and are closely associated with y-o-y mountain whitefish (Prosopium williamsoni). Both species remained in these backchannels until mid to late June. At that time, y-o-y of both species abandoned these rearing areas. Beach seining was first conducted in the shoreline areas of Ennis Reservoir on June 16, when y-o-y grayling and whitefish were captured in the

backwater areas at the head of the reservoir (the south end) (Fig. 4). Additionally, 30 y-o-y grayling were captured at the mouth of Meadow Creek on July 1, indicating the possibility of a grayling spawing run up that stream. Plans for the 1995 field season include assessing grayling movements up this stream. Beach seining and purse seining in the reservoir throughout the summer and into the fall of 1994 became more difficult and less efficient as the macrophytes developed. Adult and juvenile grayling were captured in beach seines, but none were captured in purse seine efforts. Kaya and Jeanes (1994) concluded through behavioral trials and field observations that the Madison/Ennis grayling population is most likely of an adfluvial lacustrine nature rather than of a fluvial nature, at least in the first four months after swim-up.

Each summer and fall since 1992, fishing guides and anglers on the Madison River report catching and releasing adult grayling as far upstream as Shelton Bridge (Sun West Bridge) in the Snoball Section of the Madison River (Fig. 2). This is a recent phenomenon. These grayling may be exhibiting fluvial behavior beyond that generally shown by Madison grayling. Fluvial behavior may be expected to be expressed in some individuals, especially as the population grows in number.

Trout Population Estimates

Rainbow Trout

Figures 6-10 illustrate population levels (± 80% C.I.) of rainbow trout in five sections of the Madison River. Additionally, population estimates were conducted on the Bypass section of the river by MPC in 1992 (Mabbott pers.comm.), and by FWP in 1994 (Fig. 11). The 1992 estimate was conducted when flows in the bypass reach ranged from 1100 to 1700 cubic-feet/second (cfs), prior to the reactivation of the Madison powerplant. The 1994 estimate was conducted when flows in the bypass reach were 90 cfs, after the Madison plant had come back online. The Madison powerplant had been offline during 1990-92 due to destruction of the penstock by a rockslide.

Rainbow trout in the Pine Butte section exhibited dramatic population declines in 1991 and 1992, and have remained at these

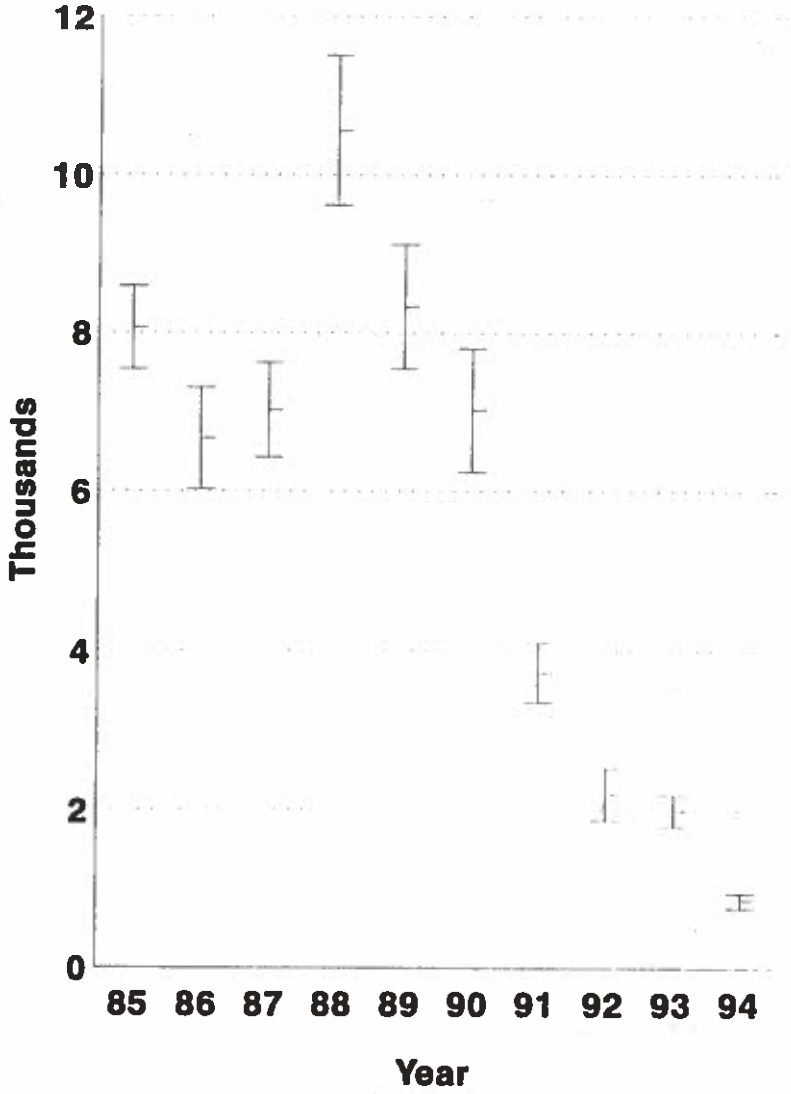

Figure 6. Rainbow trout population estimates in the Pine Butte section of the Madison River.

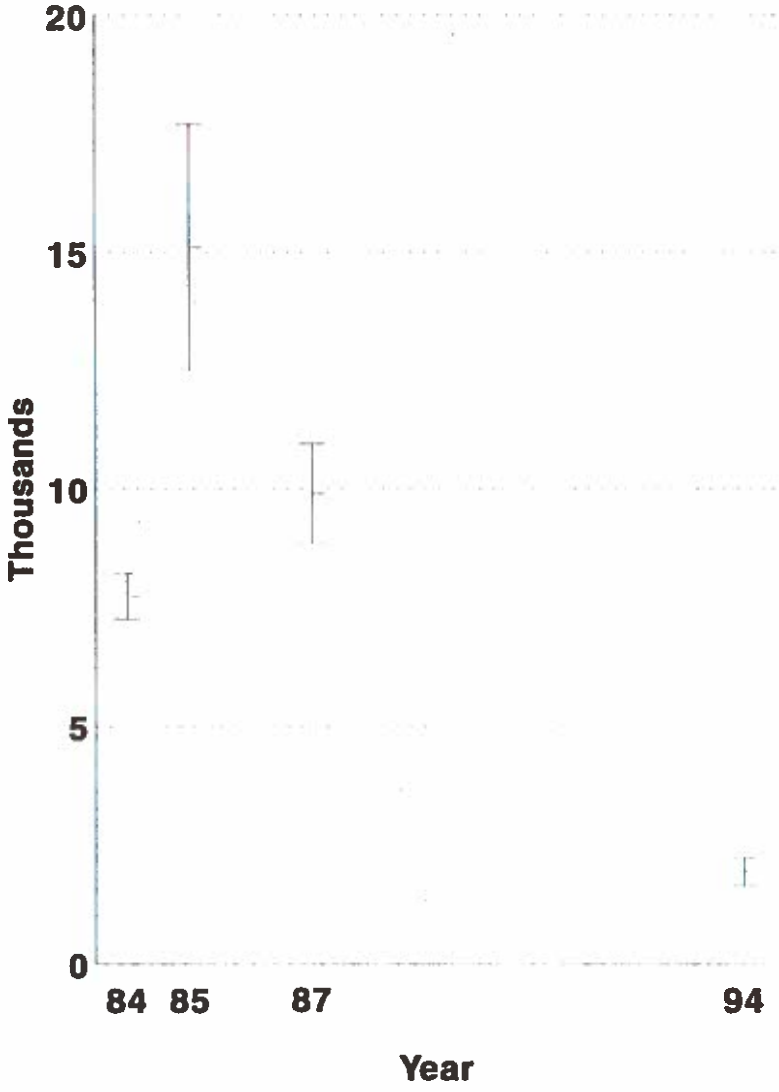

Figure 7. Rainbow trout population estimates in the Snoball section of the Madison River.

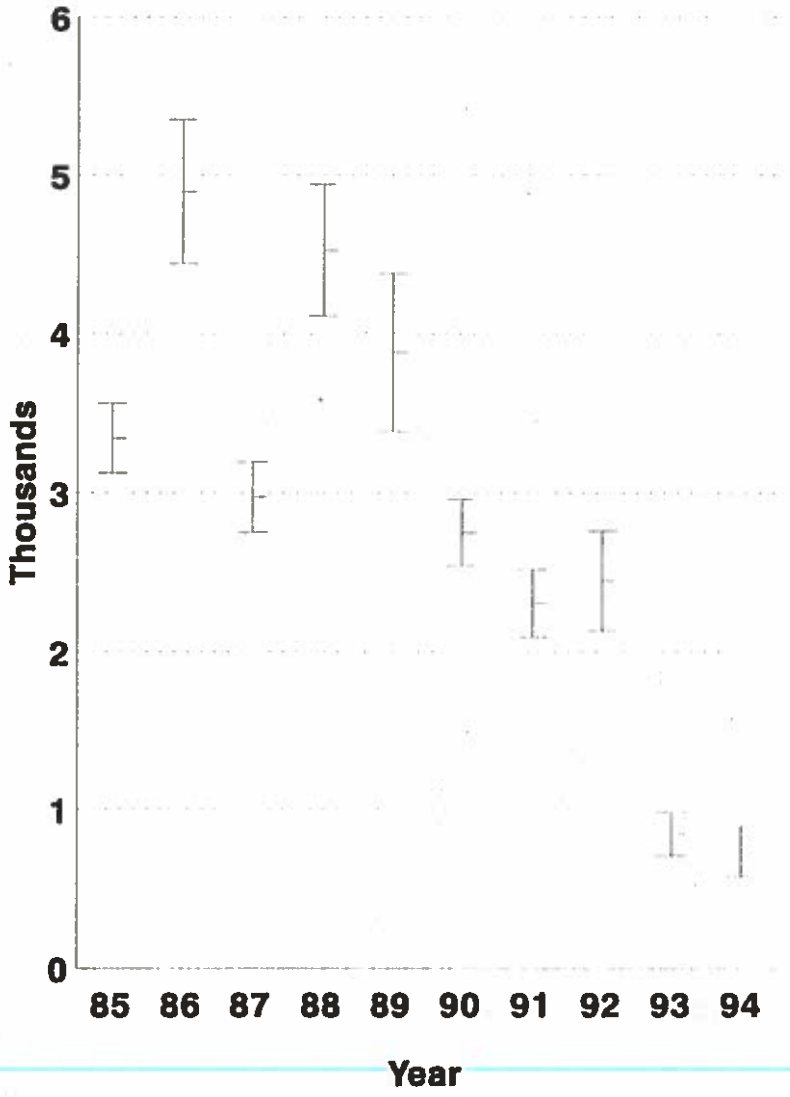

Figure 8. Rainbow trout population estimates in the Varney section of the Madison River.

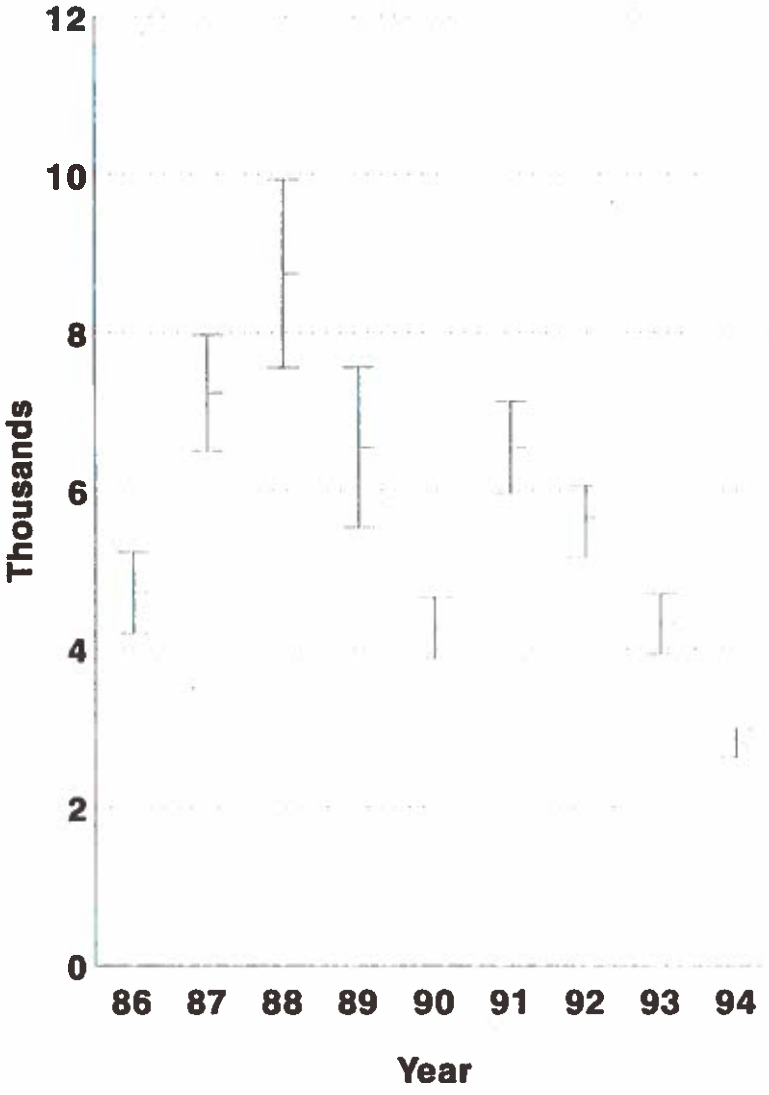

Figure 9. Rainbow trout population estimates in the Norris section of the Madison River.

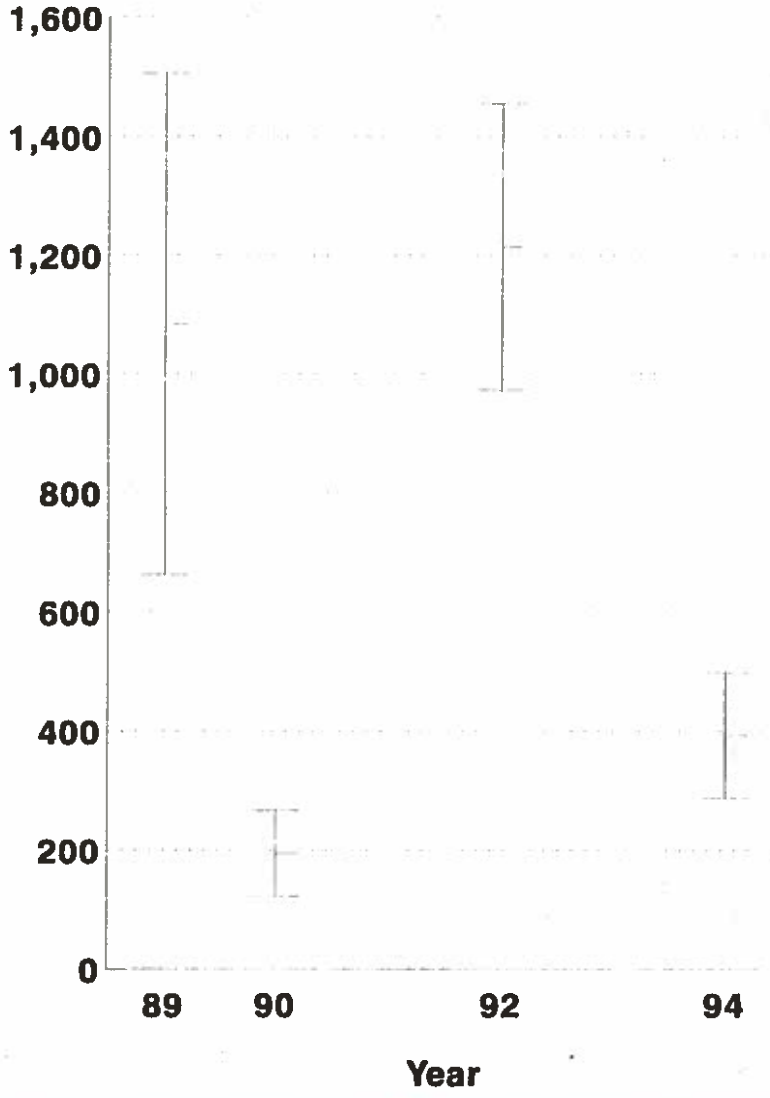

Figure 10. Rainbow trout population estimates in the Greycliff section of the Madison River.

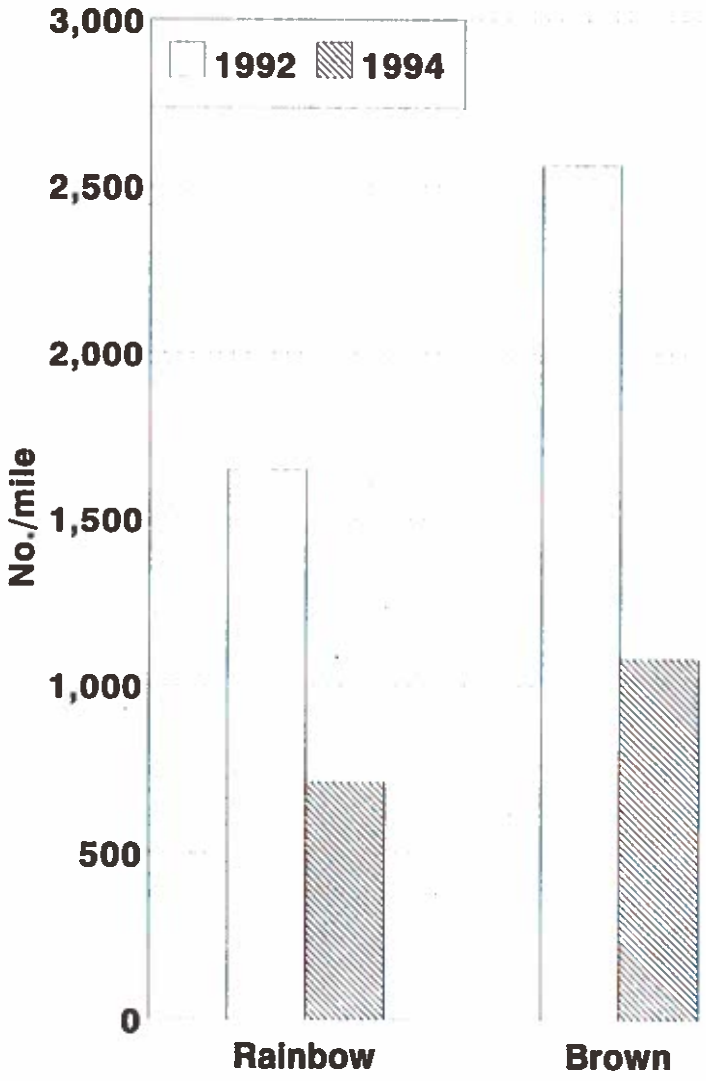

Figure 11. Population estimates of rainbow and brown trout in the Bypass section of the Madison River.

low levels since. The same phenomenon occurred approximately 30 miles downstream in the Varney section two years later, in 1993 and 1994. Investigations by FWP personnel of flow patterns, affects of angling, affects of electrofishing, disease history, changes in water quality, predation, and populations of aquatic invertebrates, revealed no obvious cause for the declines. In December 1994, young-of-the-year fish were collected from the Pine Butte section for disease testing. These tests revealed the presence of whirling disease (Myxobolus cerebralis), a parasitic protozoan, in 18 of 27 y-o-y rainbow trout. Subsequently, y-o-y rainbow and brown trout and mountain whitefish were collected from other sections of the Madison River (Hebgen-to-Quake river section, Raynolds Pass, McAtee, Blaine Spring Creek, Valley Garden, Bypass, and Norris). Examination of these specimens revealed the disease to be present in all sampled areas of the mainstem Madison River downstream of Quake Lake, except the Norris section. The disease was also detected in y-o-y trout collected from Blaine Spring Creek, a tributary to the Madison which provides water to the Ennis National Fish Hatchery. The disease was not detected in fish collected upstream of Quake Lake (Table 5), or in fish collected from the Ennis Hatchery. Analyses were conducted by USFWS personnel at the Bozeman Fish Technology Center.

The susceptibility of other species, such as grayling, to whirling disease will be determined as soon as possible. It is possible that some of the juvenile grayling collected during 1994 from Ennis Reservoir may be old enough to show the disease if it is present. Direct field observations of y-o-y grayling and whitefish in the Channels section of the Madison from shortly after emergence to mid-June, when they moved into the reservoir, did not show evidence of the disease. However, the development of the disease in y-o-y rainbows is such that it would not be expected to manifest itself any earlier than September or October. The same phenomenon probably holds true for other salmonids such as grayling.

Brown Trout

Figures 12-16 illustrate population levels (± 80% C.I.) of brown trout in five sections of the Madison River. It appears that brown trout populations are presently unaffected by whirling

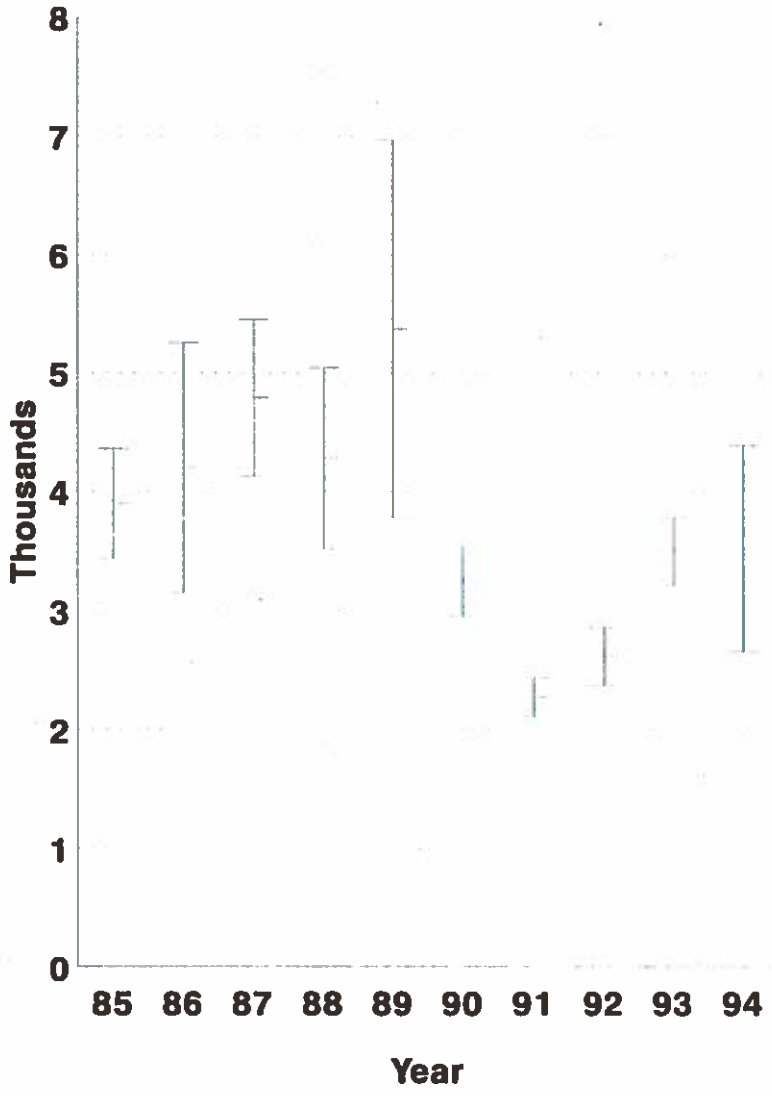

Figure 12. Brown trout population estimates in the Pine Butte section of the Madison River.

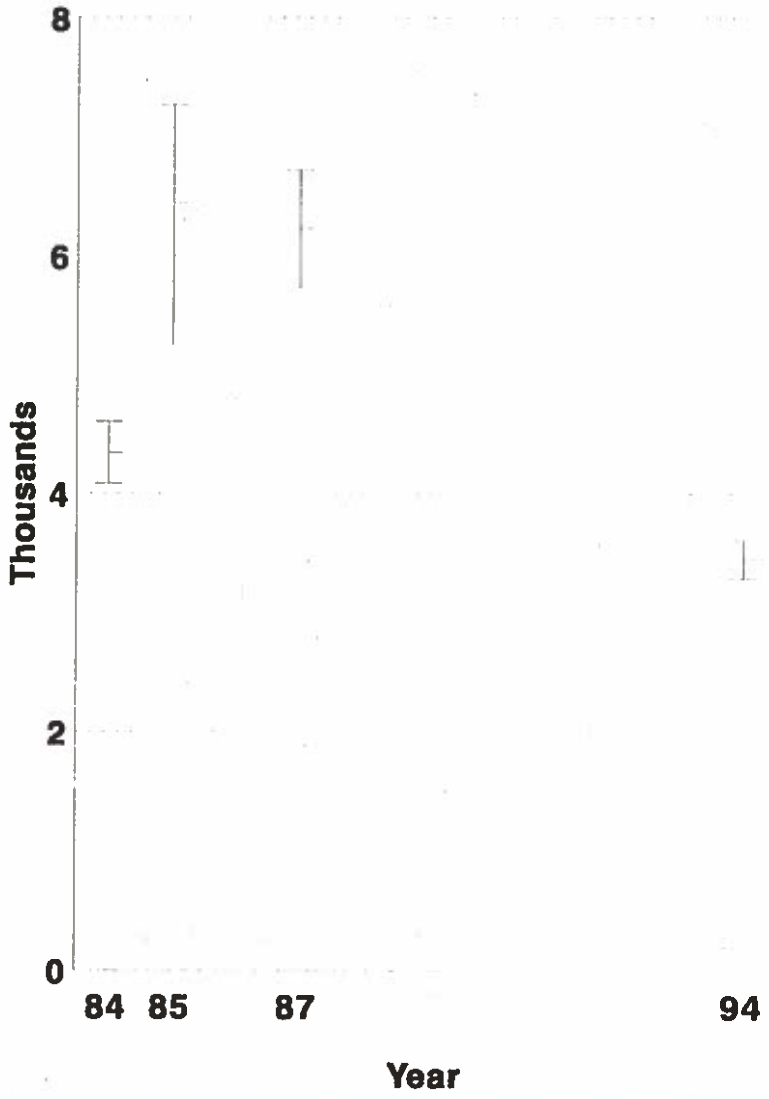

Figure 13. Brown trout population estimates in the Snoball section of the Madison River.

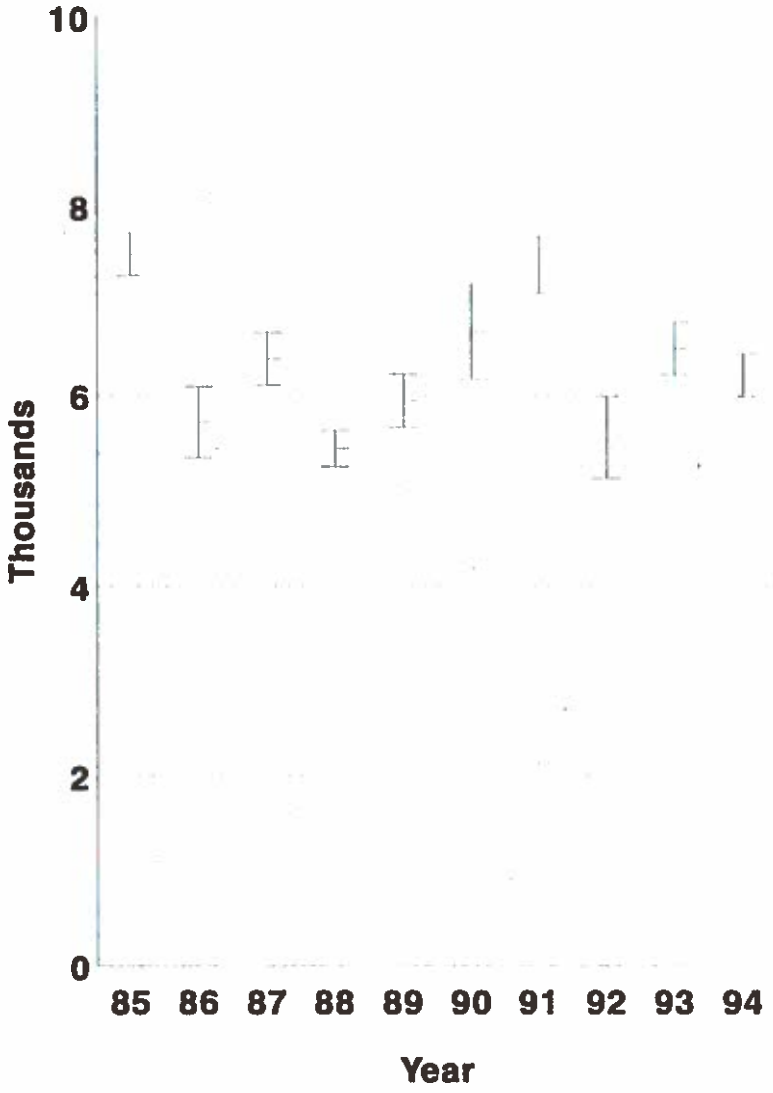

Figure 14. Brown trout population estimates in the Varney section of the Madison River.

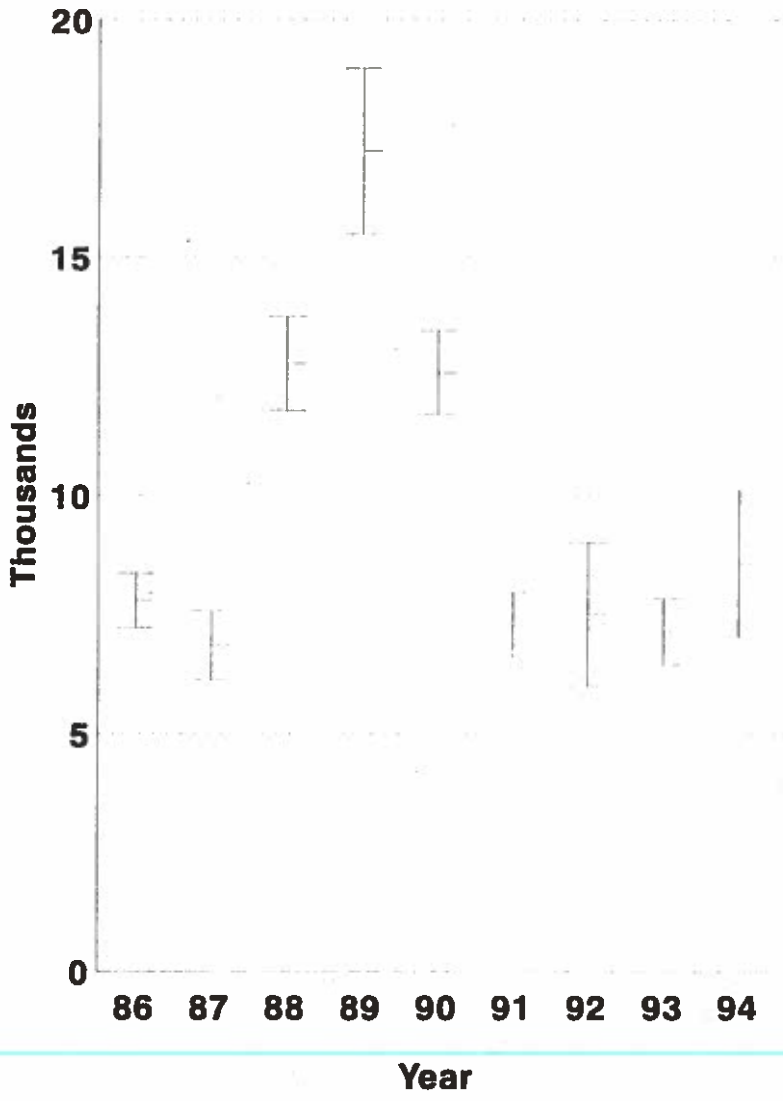

Figure 15. Brown trout population estimates in the Norris section of the Madison River.

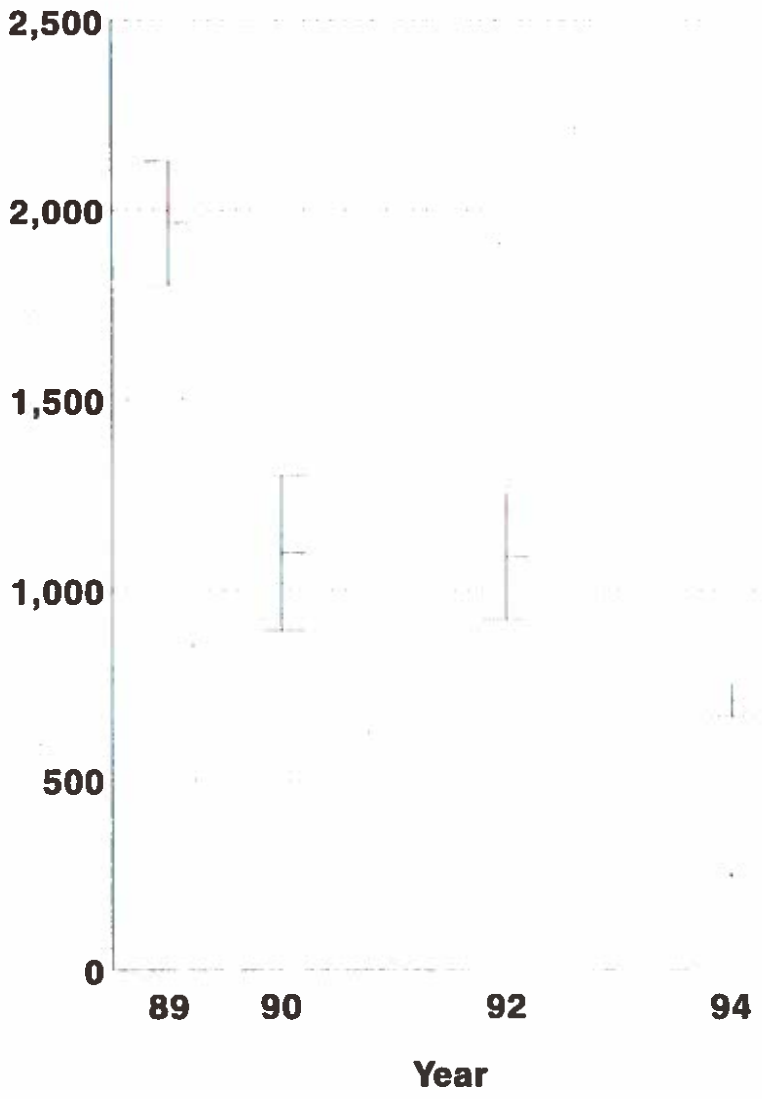

Figure 16. Brown trout population estimates in the Greycliff section of the Madison River.

disease, though spores of the parasite have been detected in y-o-y brown trout (Table 5). To date, brown trout have not filled the biomass void left by the reduction of the rainbow trout population.

Table 5. Results of tests conducted as of 2/13/95 to determine the incidence of whirling disease in Madison River salmonids.

River section	Date collected	Number/species[1/] collected	analyzed	Positive
Hebgen/Quake	1/3/95	20 Rb	16	0
		1 LL	1	0
Raynolds Pass	12/22/94	20 Rb	20	8
		6 LL	6	1
Pine Butte	12/6,7/94	27 Rb	27	18
McAtee	1/10/95	7 Rb	0	
		15 LL	0	
Blaine Spring Creek	1/10/95	4 Rb	4	4
Valley Garden	12/21/94	12 Rb	6	3
		6 LL	6	5
		6 MWF	6	0
Bypass	12/22/94	23 Rb	12	0
		6 LL	6	1
Norris	12/28/94	20 Rb	10	0

[1/] Rb= rainbow trout; LL= brown trout; MWF= mountain whitefish

Thermal Monitoring

Appendix Figure 2 contains thermographs for each StowAway location from early July through mid-October, 1994. The charts

are arranged in order from upstream (Ennis) to downstream (Greycliff). The maximum, average, and minimum temperature for each period are listed in Table 6. During the period monitored, the magnitude of daily temperature fluctuations was similar for each location, except the County Bridge (over Ennis Reservoir) and the Dam. As expected, these two locations showed little diurnal fluctuation compared to other stations. At the four sites above Ennis Reservoir (Ennis, Valley Garden, Eagles Nest, and Inlet), the daily minimum temperatures during July and August always dropped below 65°F. Downstream of Ennis Reservoir, at the Bear Trap Mouth and Norris sites, the daily minimum temperatures rarely dropped below 65°F. Also, the average daily temperature at these two sites seems to rise thoughout July and into August moreso than the four sites upstream of the reservoir. Similar trends hold true for the Black's Ford and Greycliff sites, though not as dramatically as at the Bear Trap and Norris sites.

CONCLUSIONS

The status of the Madison grayling population should continue to be monitored. Additional and consistent manpower and readily available equipment are required to adequately sample the population for enumeration and behavioral traits, both during the spring spawning run and throughout the remainder of the year in the reservoir and river.

The fluvial nature of Madison grayling is still not definitively known. Most evidence suggests an adfluvial lacustrine population. However, judging by angler reports in recent years, at least some individuals within the population exhibit fluvial qualities by residing in the Madison River up to 30 miles upstream of Ennis Reservoir as late as September. Efforts to determine the fluvial component of the population will be undertaken during the 1995 field season. This information is necessary to determine where Madison grayling fit in the recovery efforts for Montana's fluvial arctic grayling. If a viable fluvial component exists, it could be selectively bred to provide an additional source of fluvial grayling for recovery efforts.

A decision on attempts to expand and supplement the population, or to select for any fluvial qualities that may exist, will need to be made. Presence of whirling disease in the Madison drainage only makes the situation more complex. The

Table 6. Maximum, average, and minimum temperatures (°F) at StowAway locations for each period monitored.

Site/period	Maximum	Average	Minimum
Ennis			
7/7-7/29	73.5 (7/25)	64.1	55.0 (7/11)
7/29-9/5	72.6 (8/11)	62.2	52.5 (9/1)
9/5-10/15	65.0 (9/8)	53.6	36.8 (10/3)
Valley Garden			
7/7-8/1	73.5 (7/25)	64.3	55.0 (7/11)
8/1-9/4	73.2 (8/11)	62.3	52.5 (9/1)
9/4-10/14	65.0 (9/6)	53.6	36.3 (10/4)
Eagles Nest			
7/7-8/1	75.7 (7/24)	65.0	55.3 (7/11)
8/1-9/4	75.1 (8/14)	62.7	52.2 (9/1)
9/4-10/14	66.4 (9/8)	53.8	35.7 (10/4)
Inlet			
7/7-8/1	76.3 (7/24,25)	65.4	55.6 (7/10,12,14)
8/1-9/4	75.7 (8/14)	63.1	52.2 (9/1)
9/4-10/14	67.3 (9/8)	54.0	36.0 (10/4)
County Bridge			
7/7-7/29	72.0 (7/26)	67.0	59.5 (7/11)
7/29-9/4	73.8 (8/5)	67.0	59.2 (9/4)
9/4-10/14	64.4 (9/6)	56.2	43.9 (10/4)
Dam			
7/7-7/31	71.4 (7/25,26)	67.2	60.6 (7/11)
7/31-9/7	72.9 (8/15)	66.8	58.4 (9/6)
9/7-10/17	62.7 (9/7,9)	55.4	45.8 (10/5)
Bear Trap mouth			
7/7-8/2	76.0 (7/25)	68.1	60.1 (7/11)
8/2-9/4	75.7 (8/5)	67.2	58.1 (9/4)
9/4-10/14	65.8 (9/7,9)	56.3	45.3 (10/5)

Table 6 (continued).

Norris			
7/7-7/29	76.9 (7/25)	67.7	59.2 (7/11)
7/29-9/4	76.3 (8/5)	67.2	57.2 (9/4)
9/4-10/14	66.4 (9/7,9)	56.1	45.0 (10/5)
Black's Ford			
7/7-8/1	78.8 (7/25)	68.4	56.7 (7/11)
8/1-9/4	79.4 (8/3)	67.2	55.9 (9/2,4)
9/4-10/14	68.4 (9/7)	56.2	44.2 (10/5,8)
Greycliff			
7/7-8/1	80.4 (7/25)	68.6	55.9 (7/11)
8/1-9/4	79.4 (8/3)	67.0	55.3 (9/2,4)
9/4-10/14	68.7 (9/7)	56.1	43.0 (10/8)

susceptibility of grayling to whirling disease is unclear. Egg-taking from Madison grayling for these efforts is temporarily suspended to prevent the accidental spread of the disease to hatcheries and uninfected waters.

As a condition for relicensing, MPC is implementing a Protection, Mitigation, and Enhancement (P,M,&E) Program for the Madison system. Funding for this program will significantly enhance the opportunity to continue the Madison grayling program, and if appropriate, expand it.

Fish, Wildlife, and Parks annual population estimates of trout populations will continue, and in the face of whirling disease, may be expanded. The participation of the P,M,&E Biologist in these annual efforts will be necessary to gain firsthand knowledge of potential P,M,&E projects.

Thermal monitoring at selected locations in the Madison River will continue with StowAway Temperature Loggers. The sites for monitoring with StowAways will be determined independently of sites established and monitored by MPC and FWP with Omnidata Datapods. This will allow the data collected to serve as a check, as well as a supplement to that collected by Datapods. This system of checks will be useful for addressing questions and concerns that may arise regarding site selection and analyses of Datapod information.

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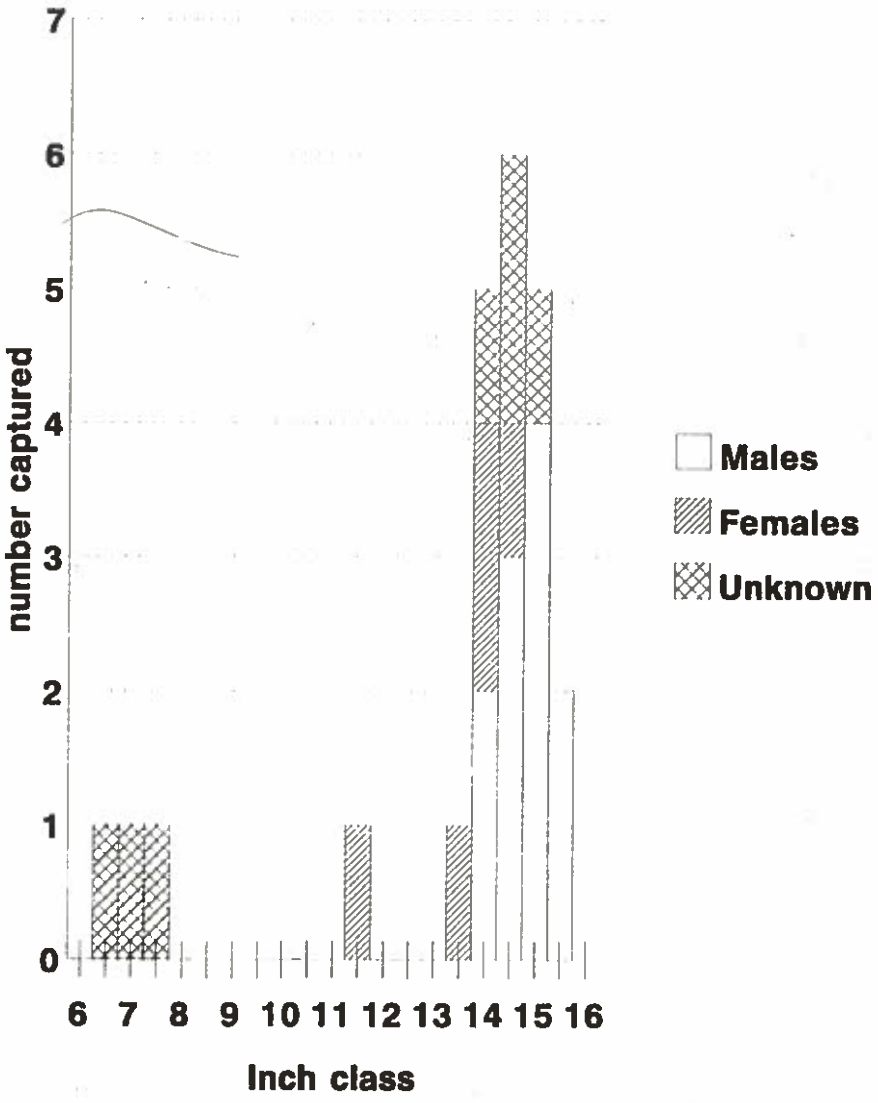
Appendix Figure 1

Madison Grayling Length Frequency

(5 pages)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Males
Females
Unknown

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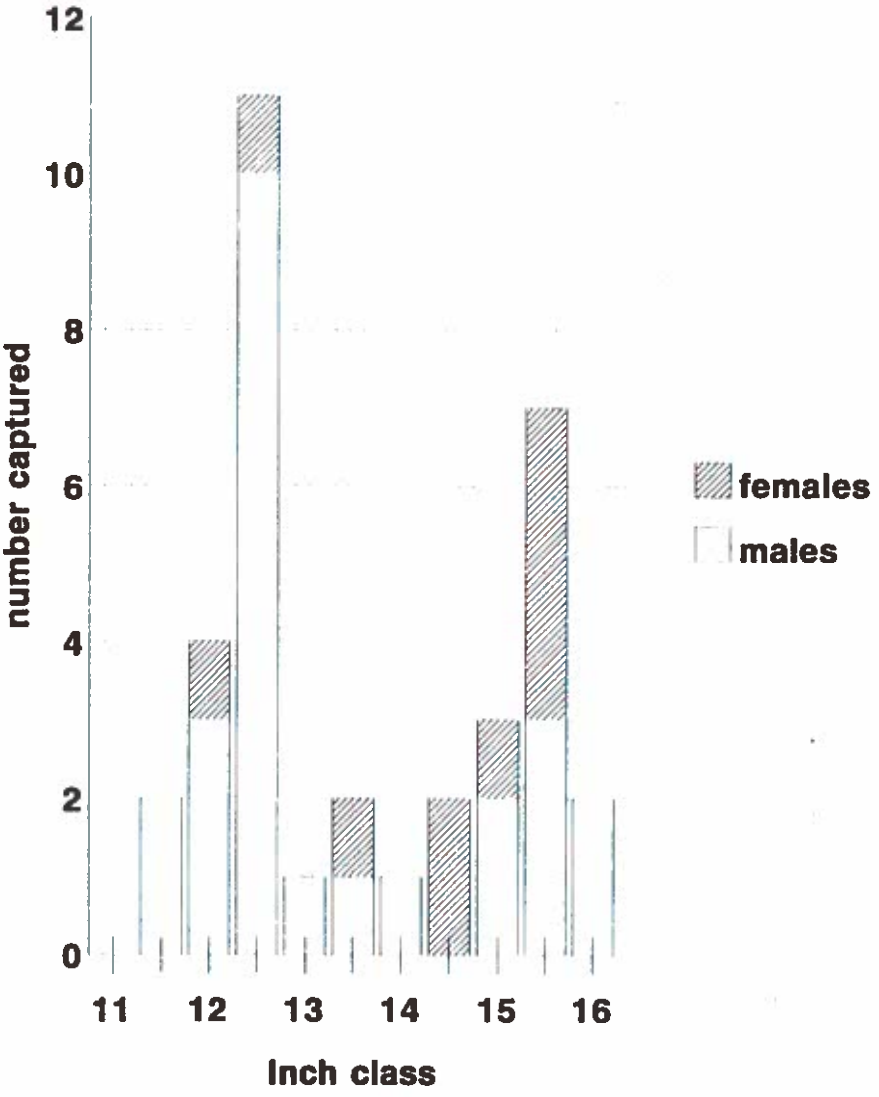
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males

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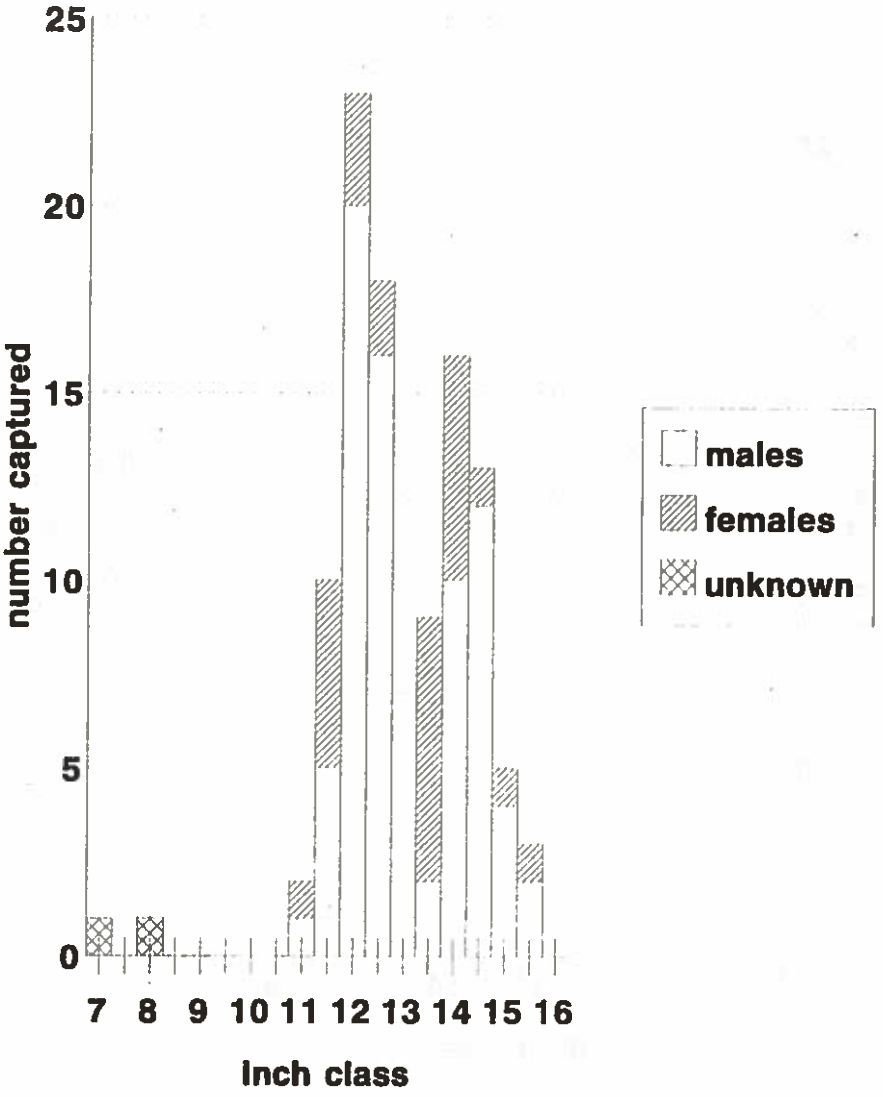
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inch class
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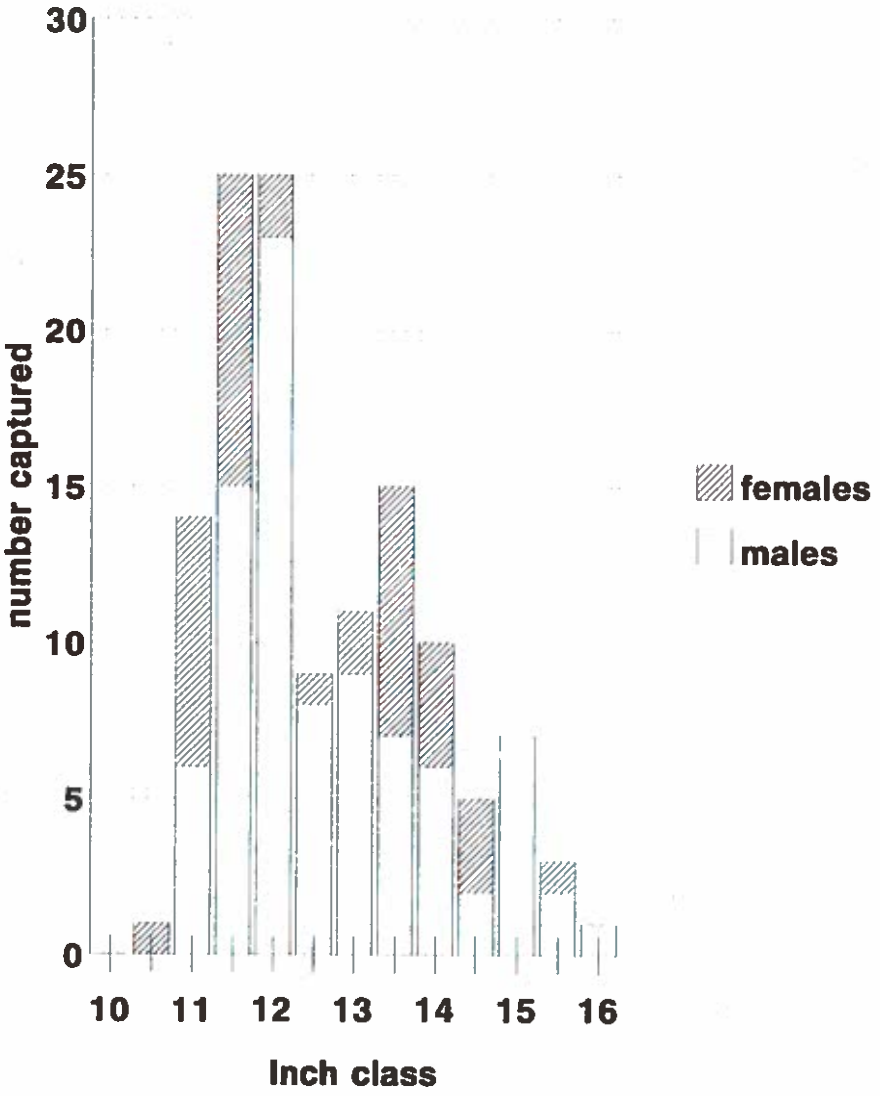
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16
Inch class
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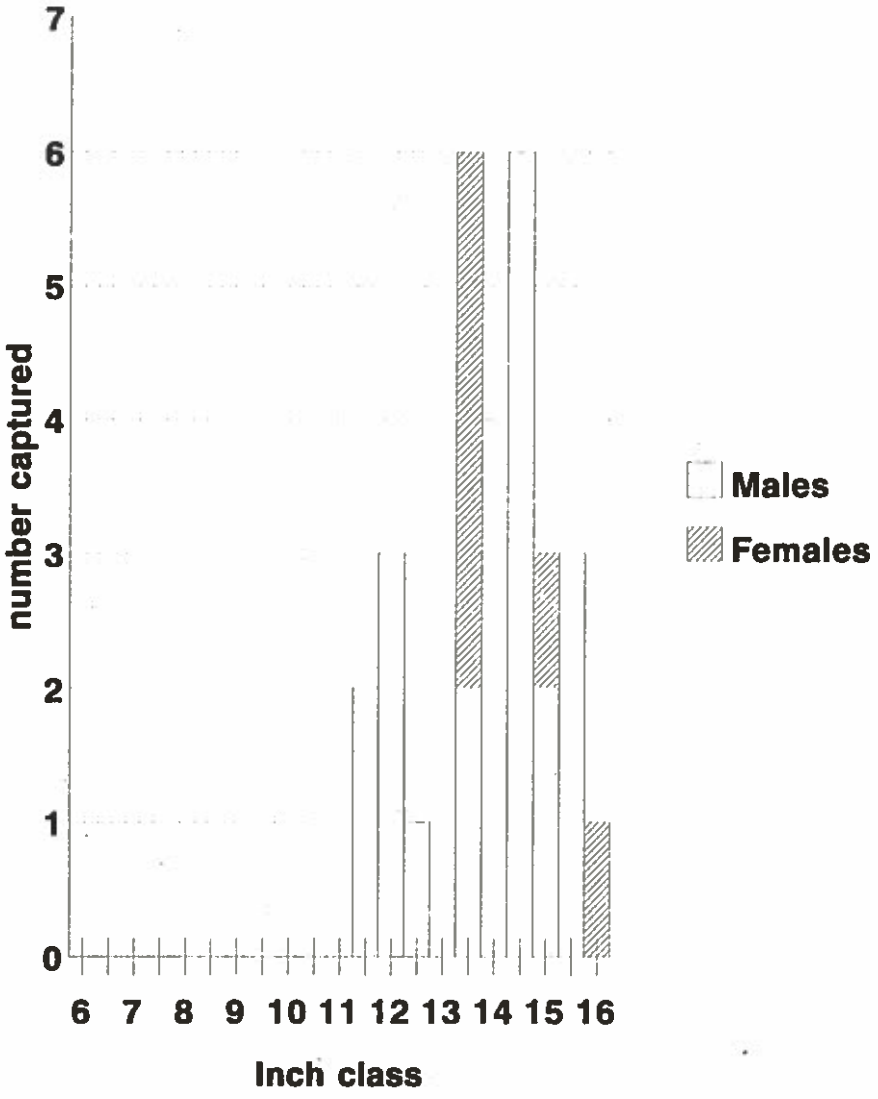
males

1993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1
0
number captured
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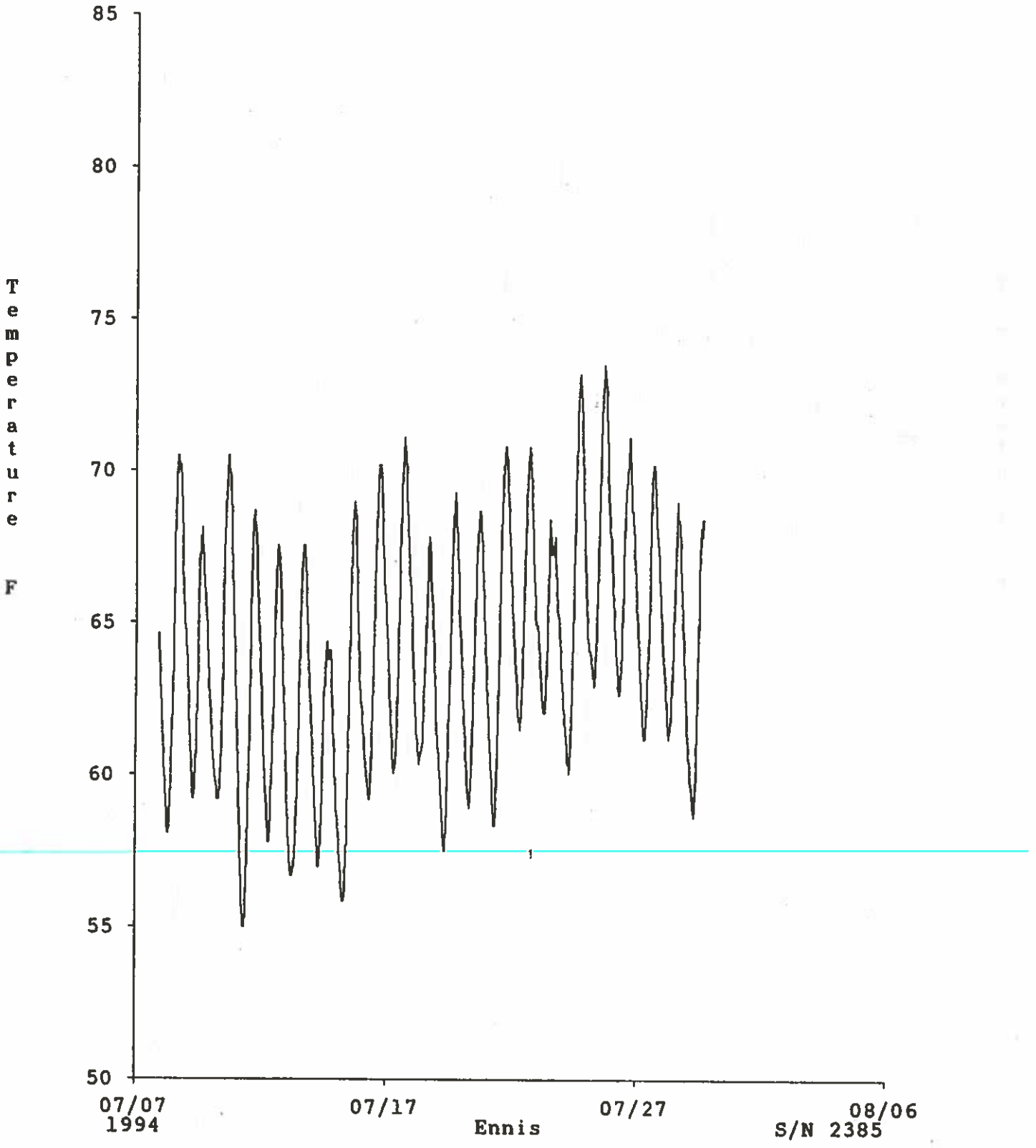
Inch class
Males
Females

1994

Appendix Figure 2

StowAway Temperature Recordings
July-October, 1994

(30 pages)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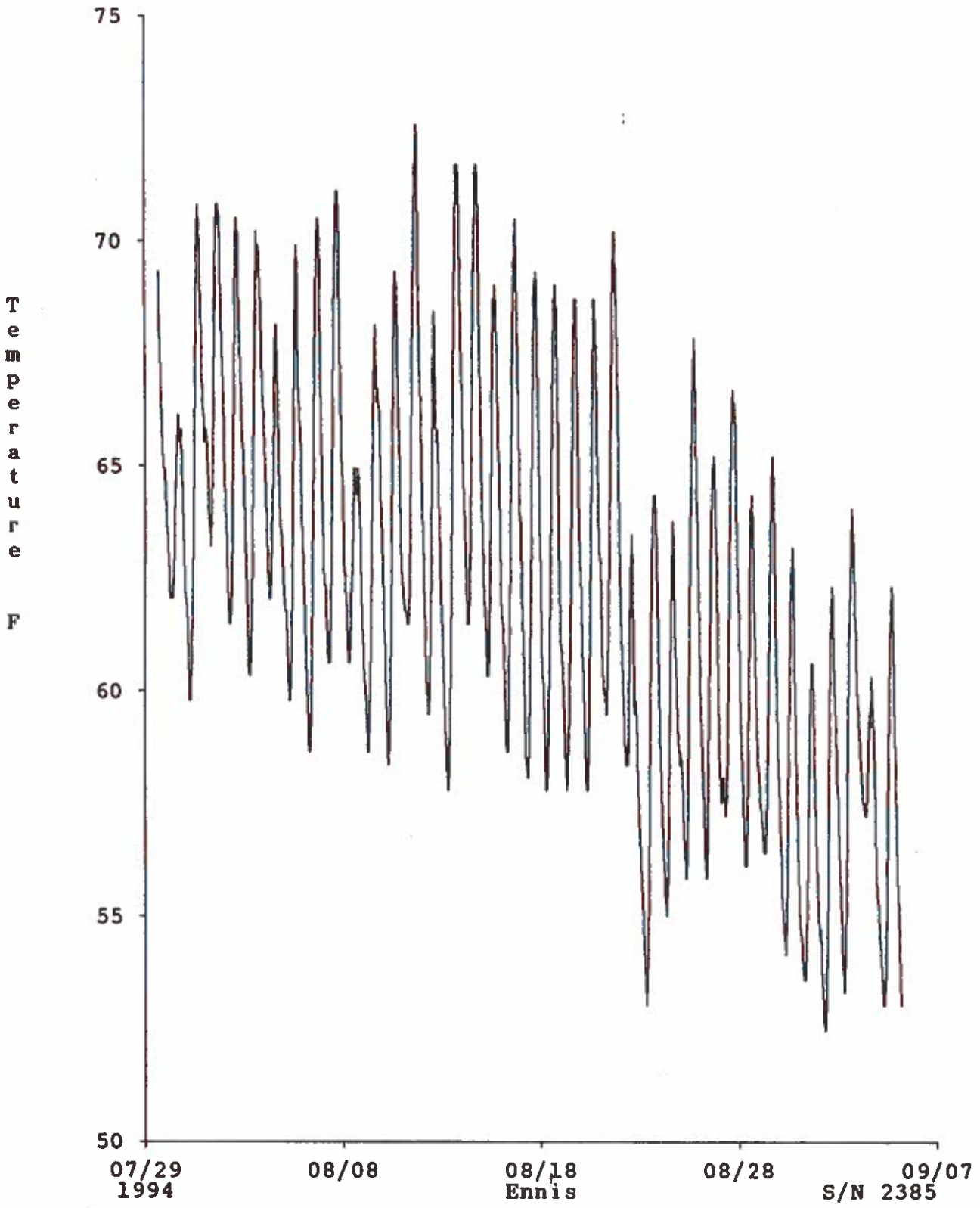
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08/18
Ennis
08/28
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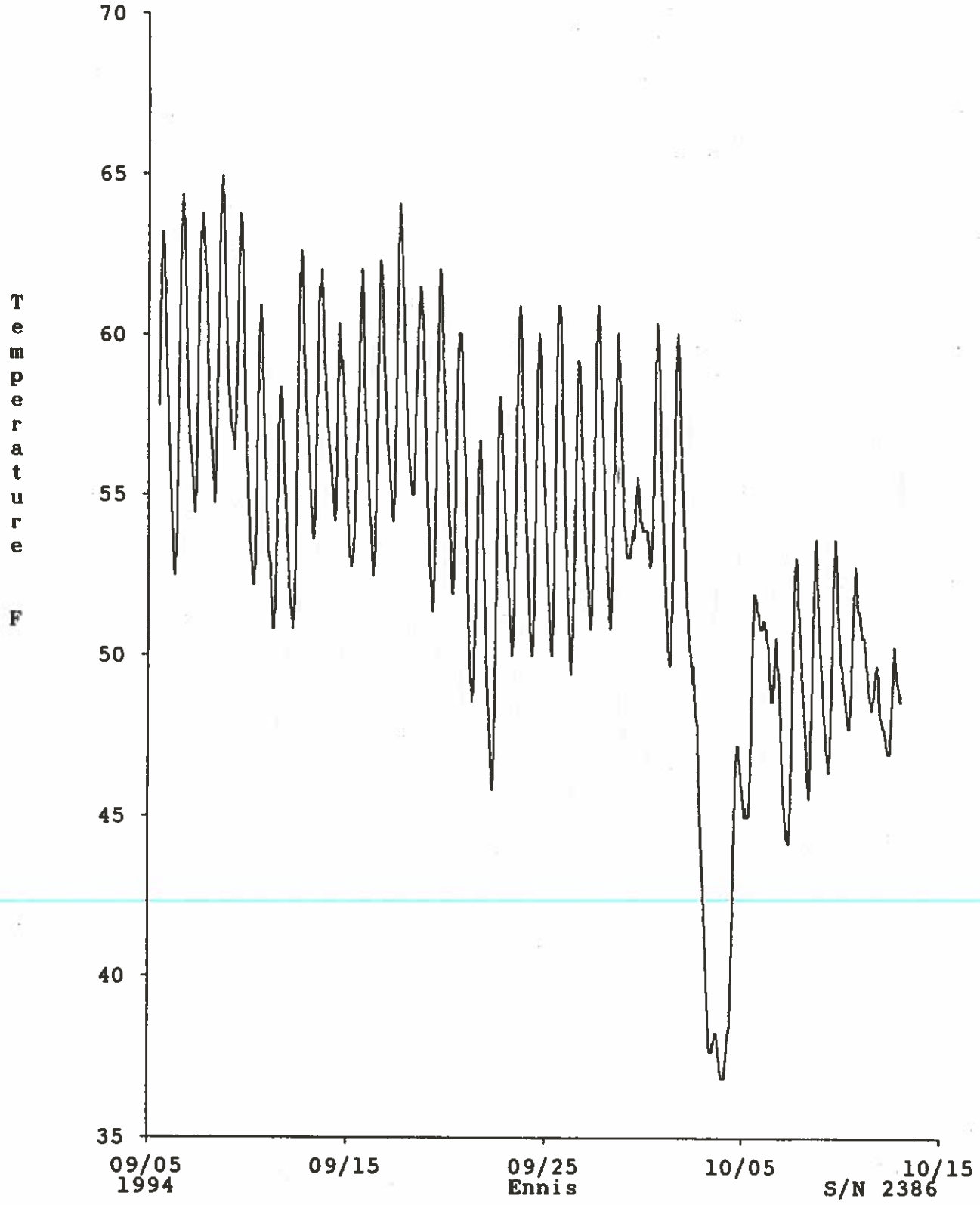
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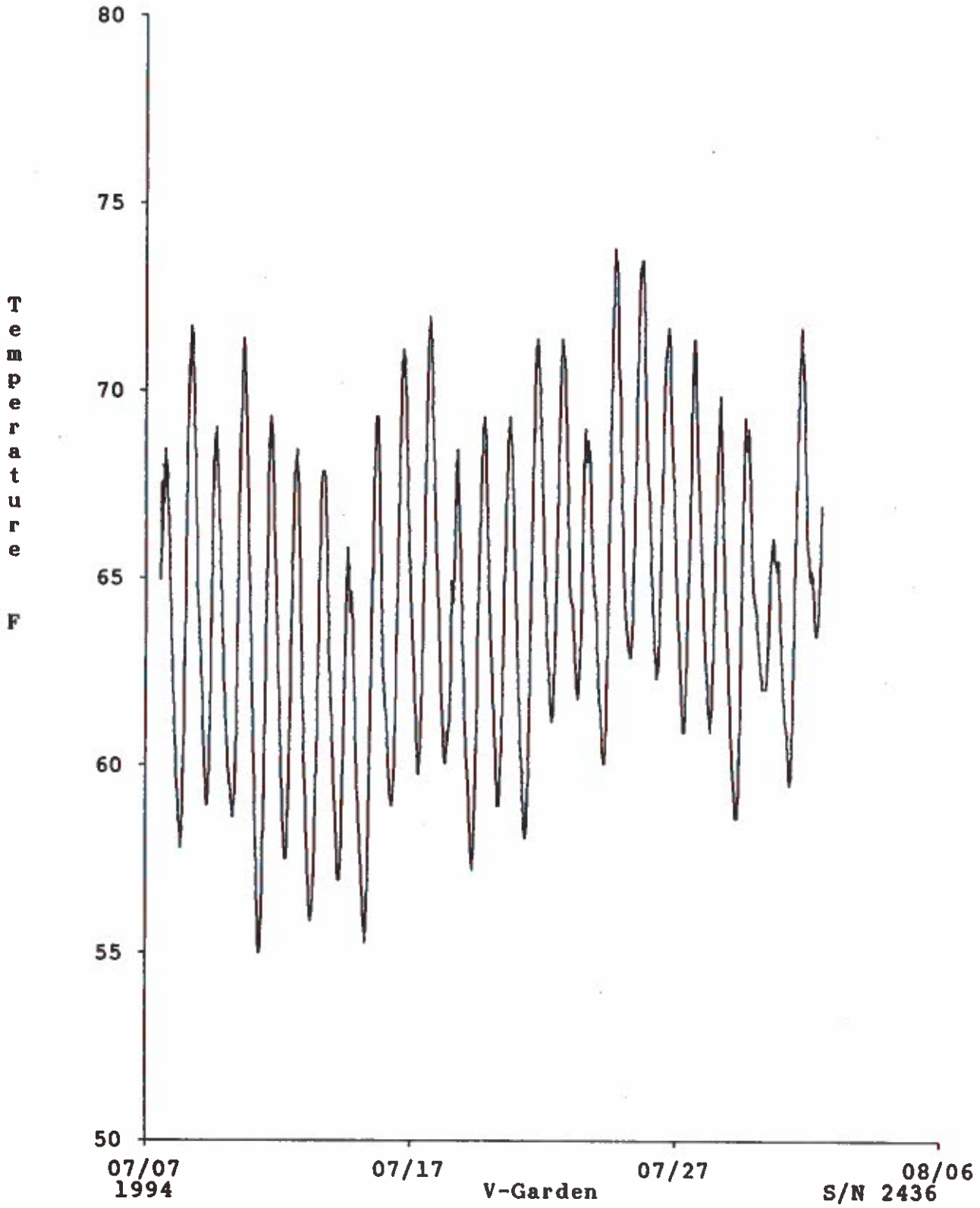
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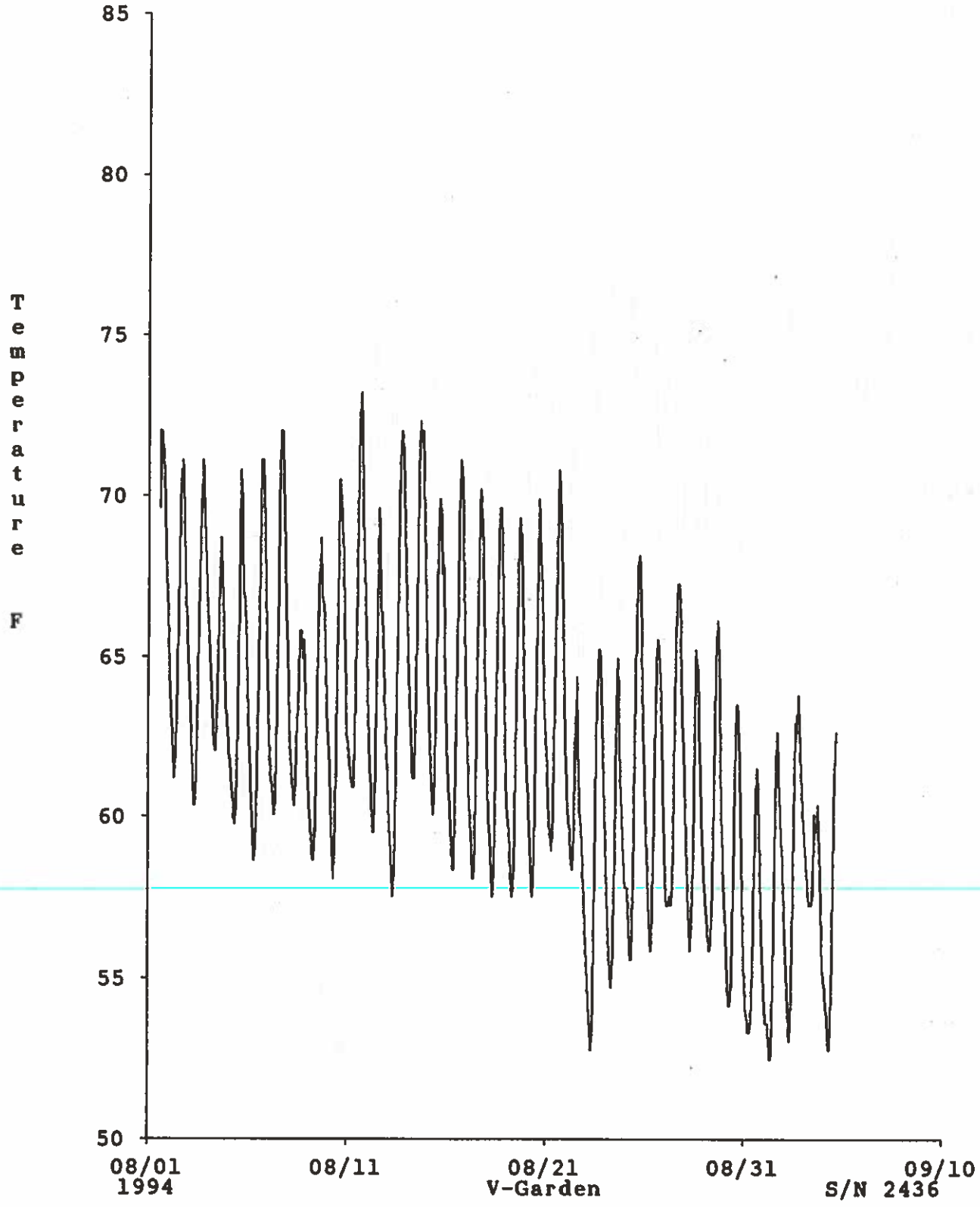
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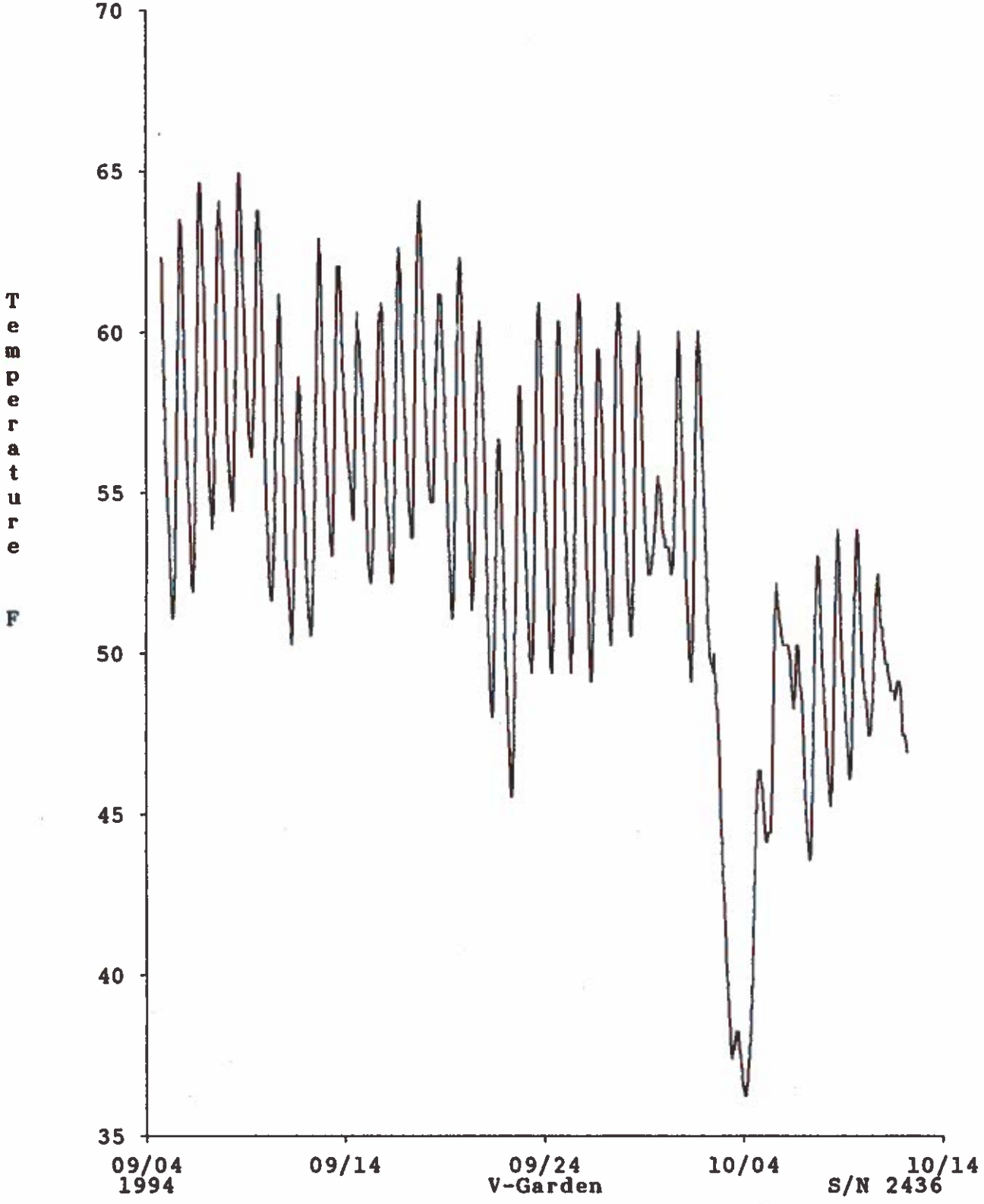
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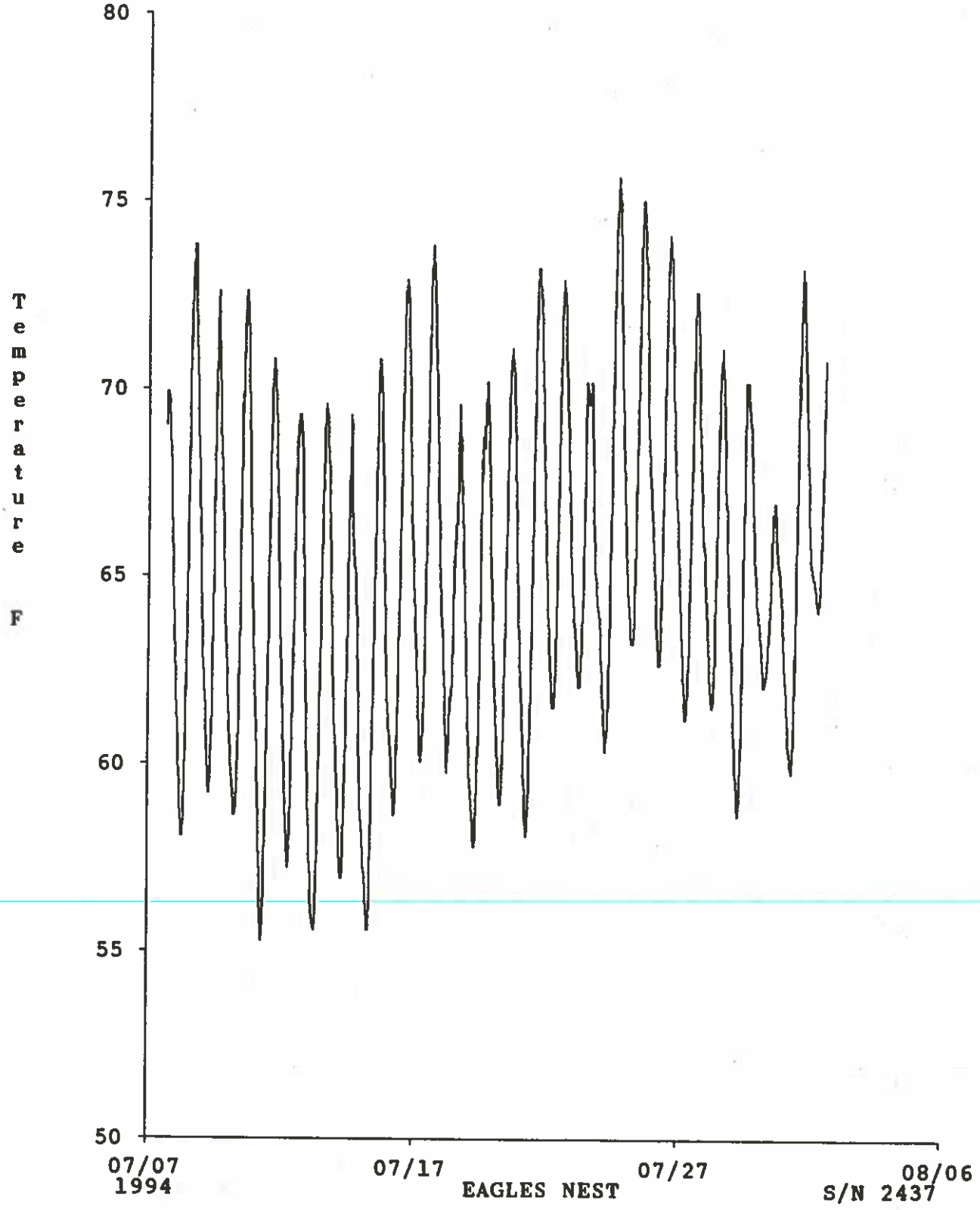
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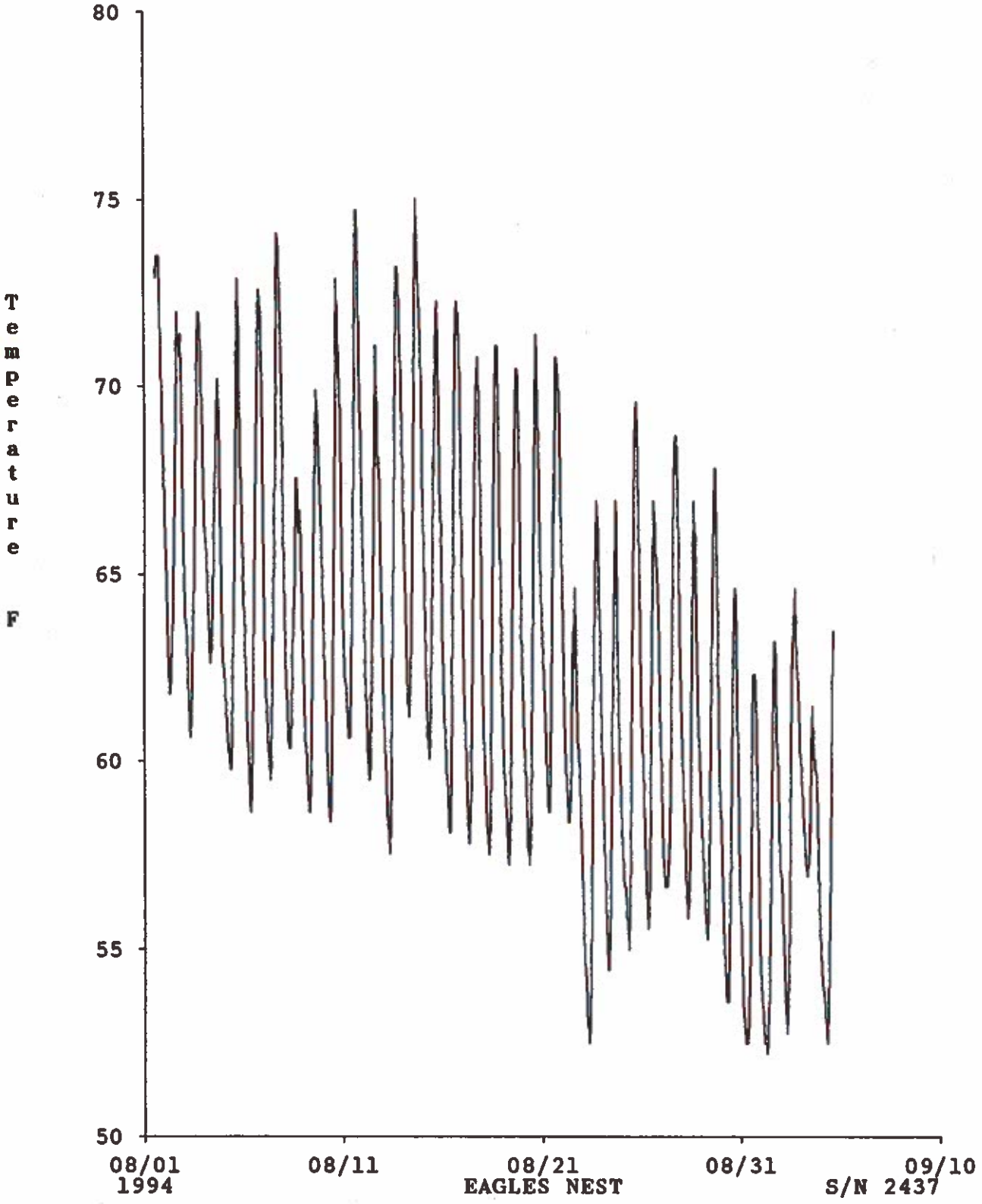
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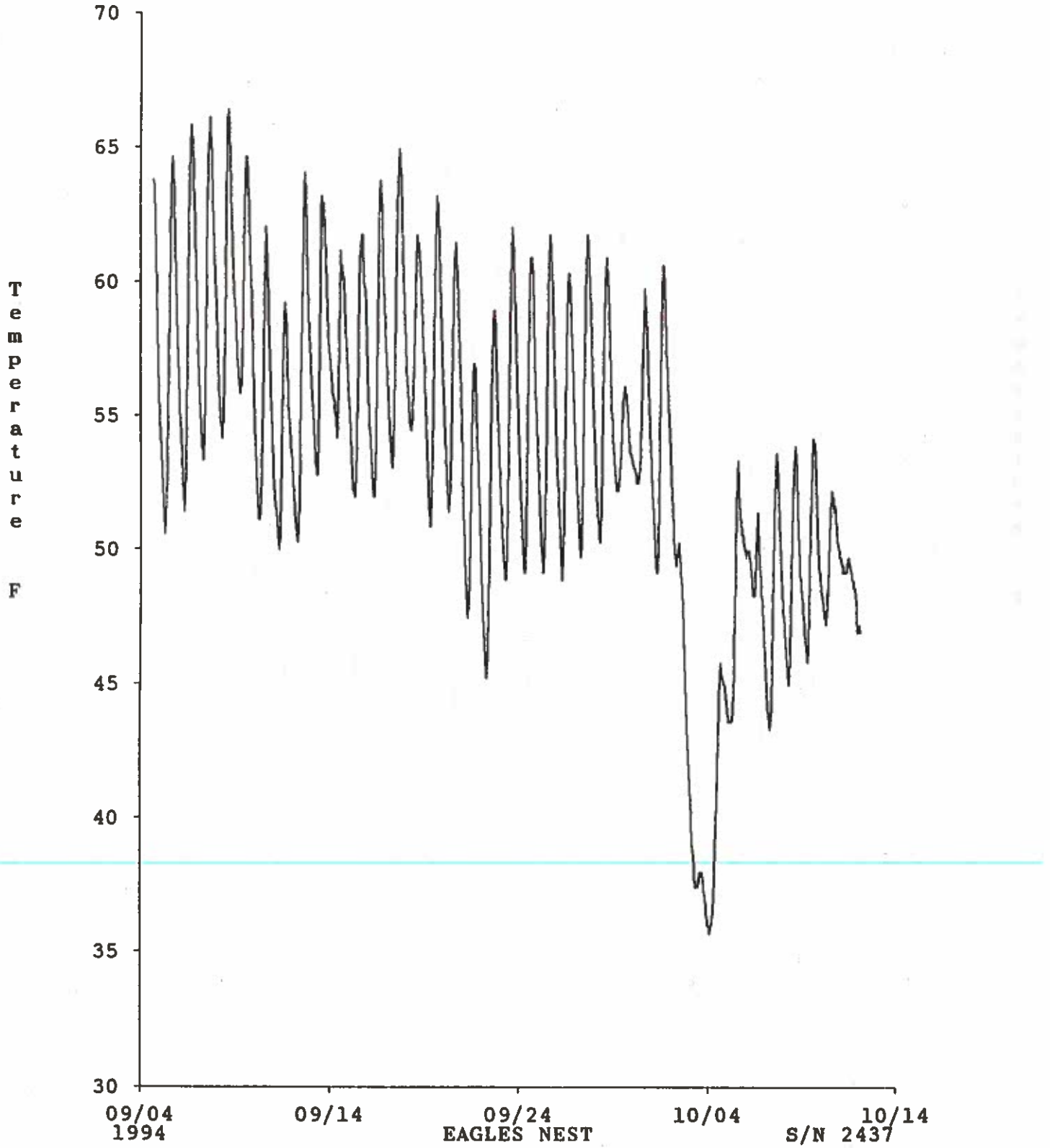
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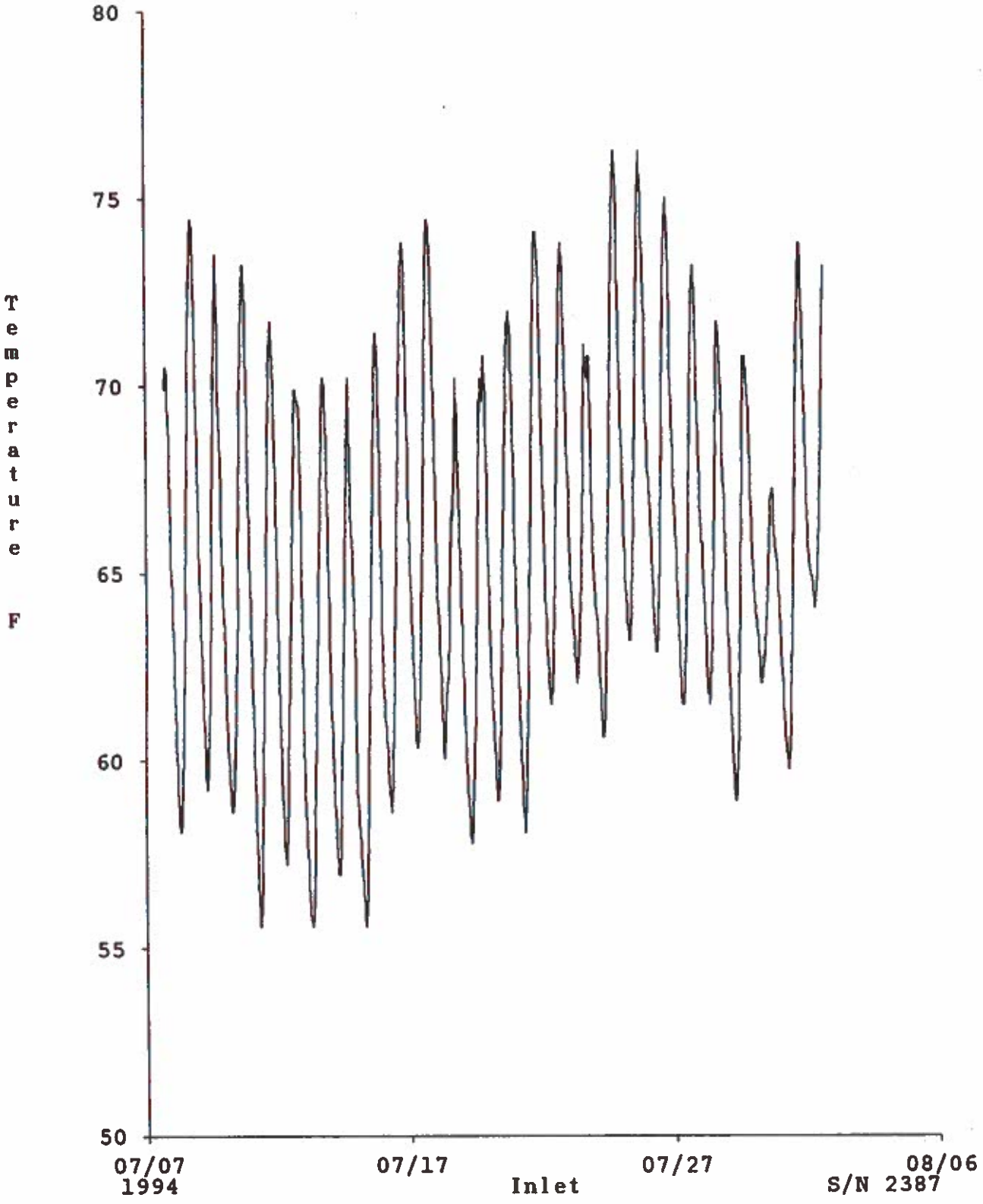
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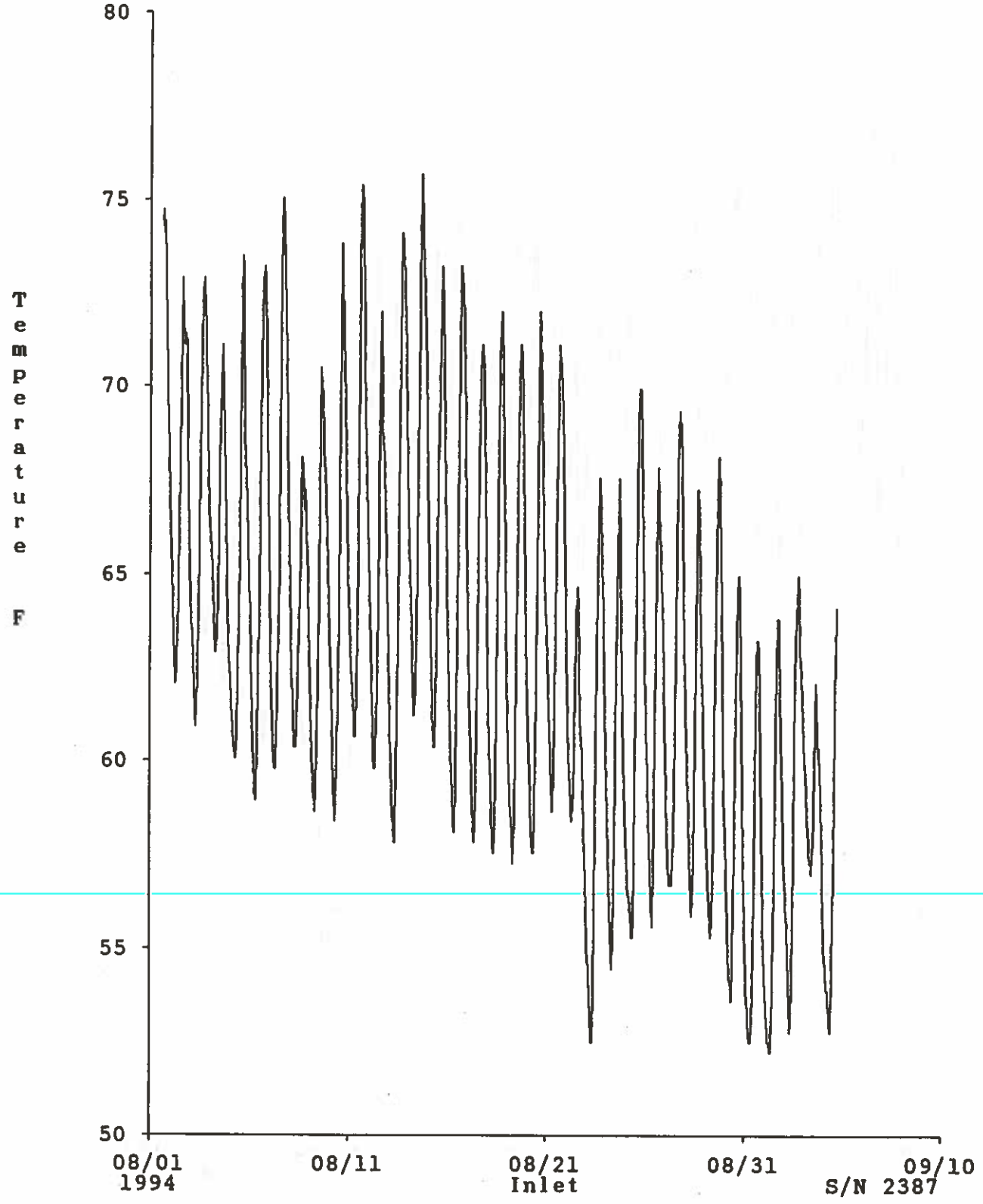
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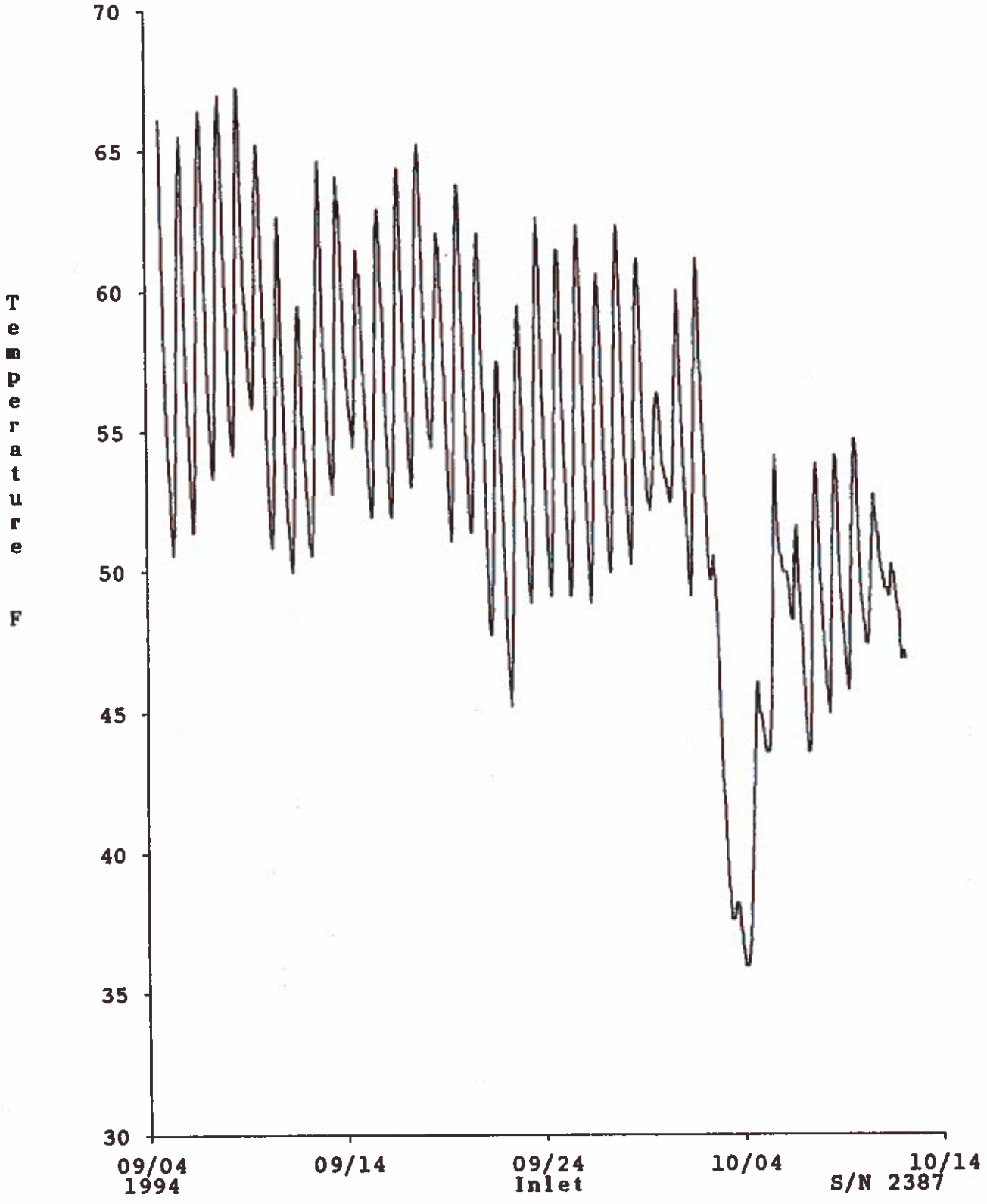
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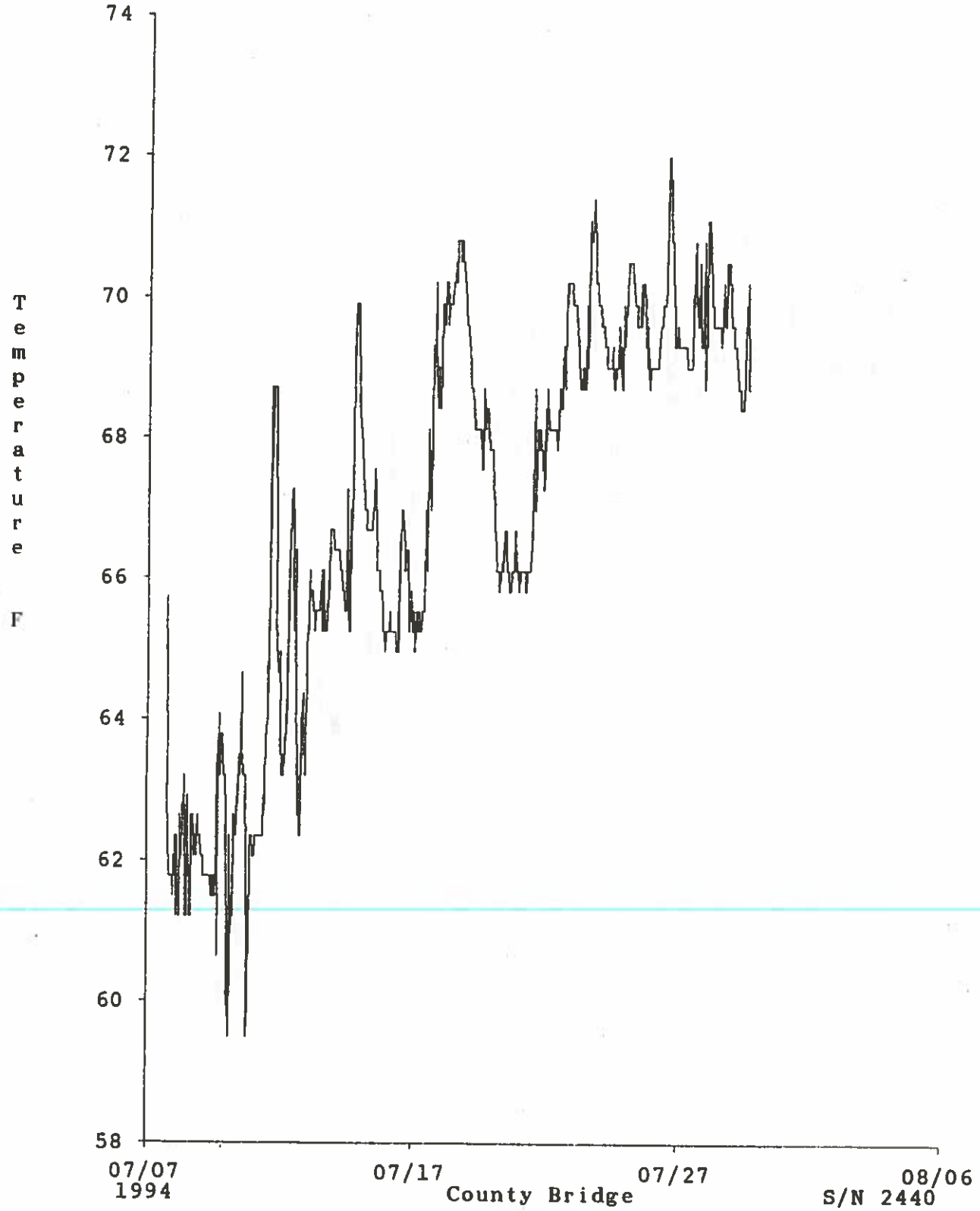
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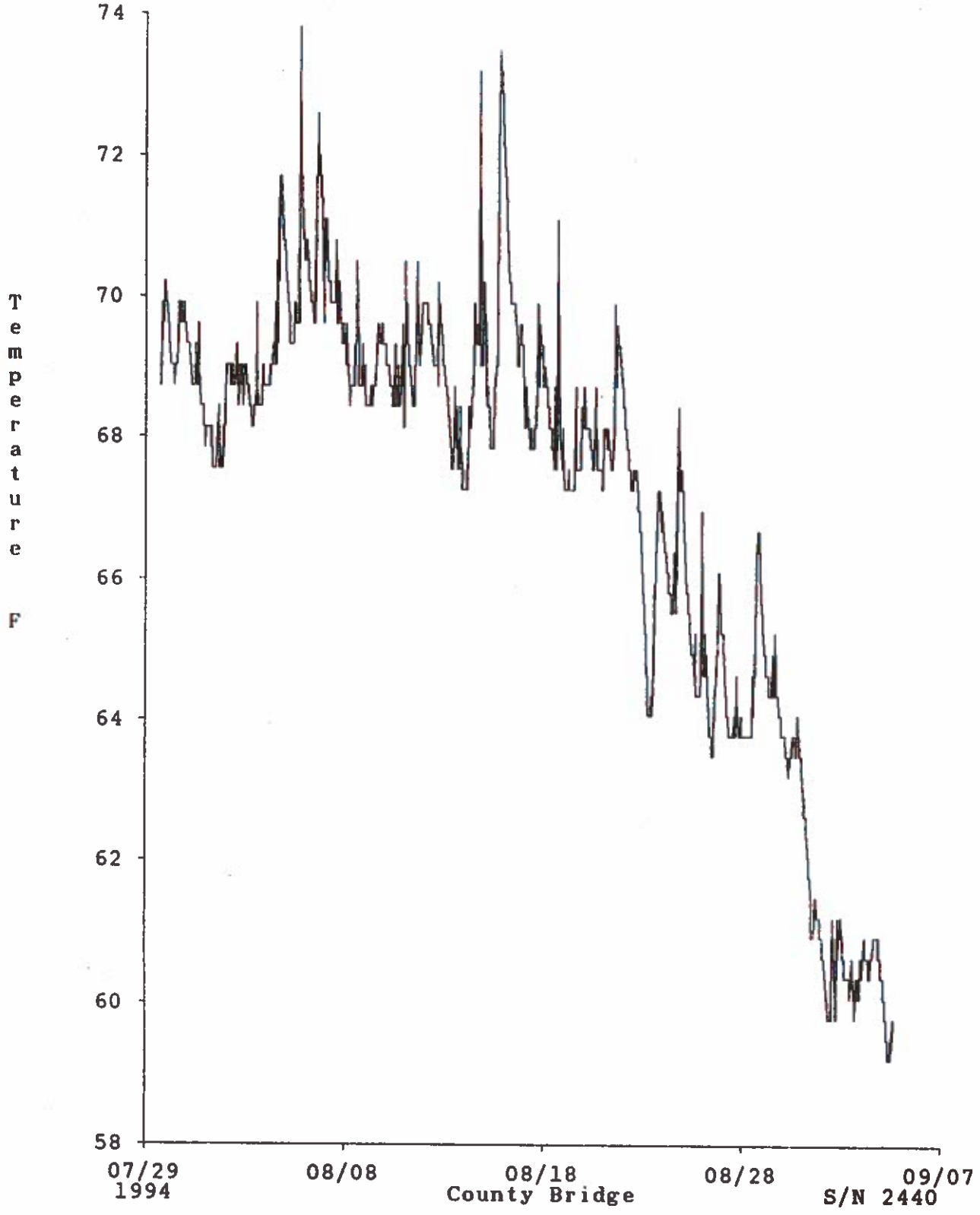
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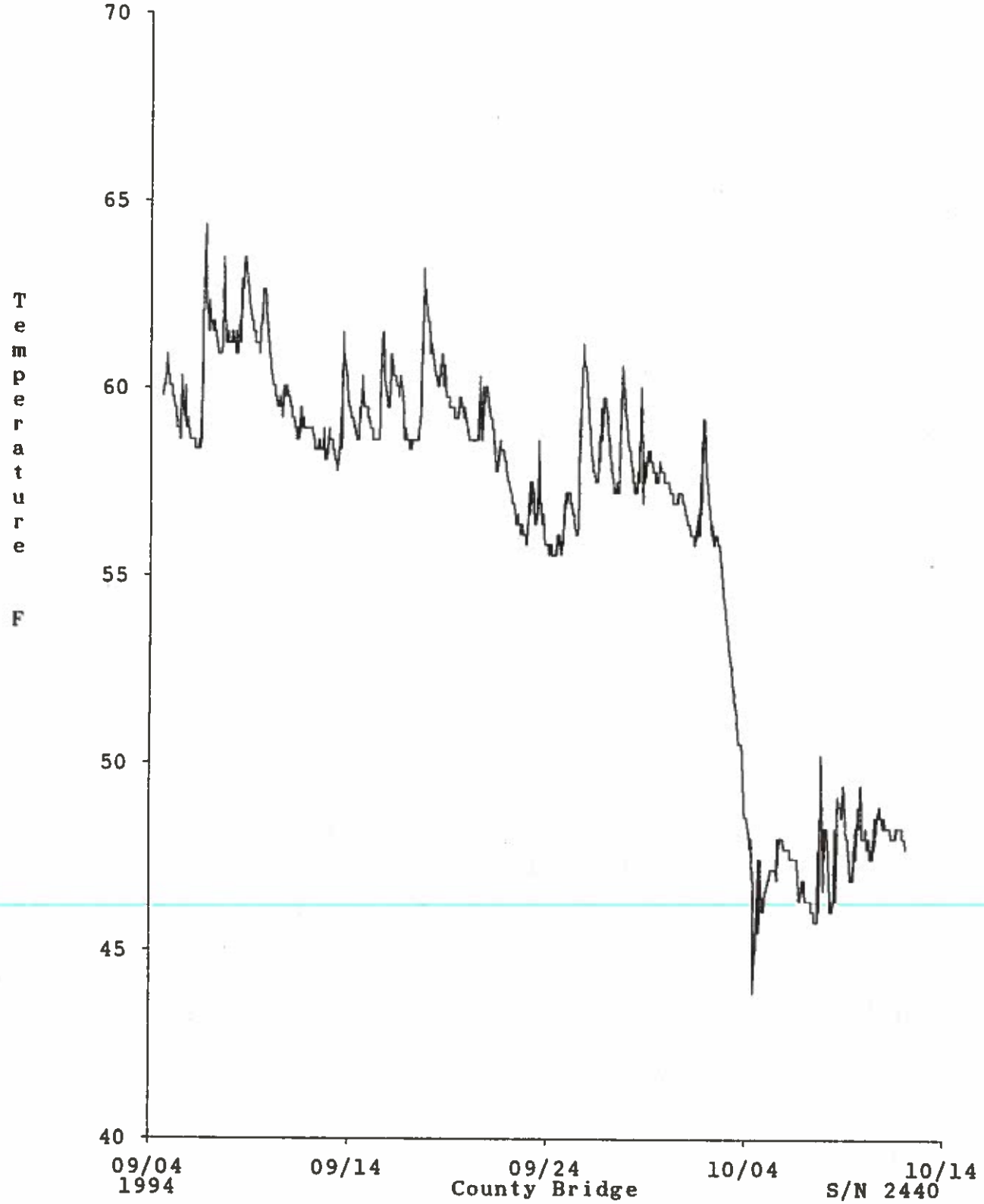
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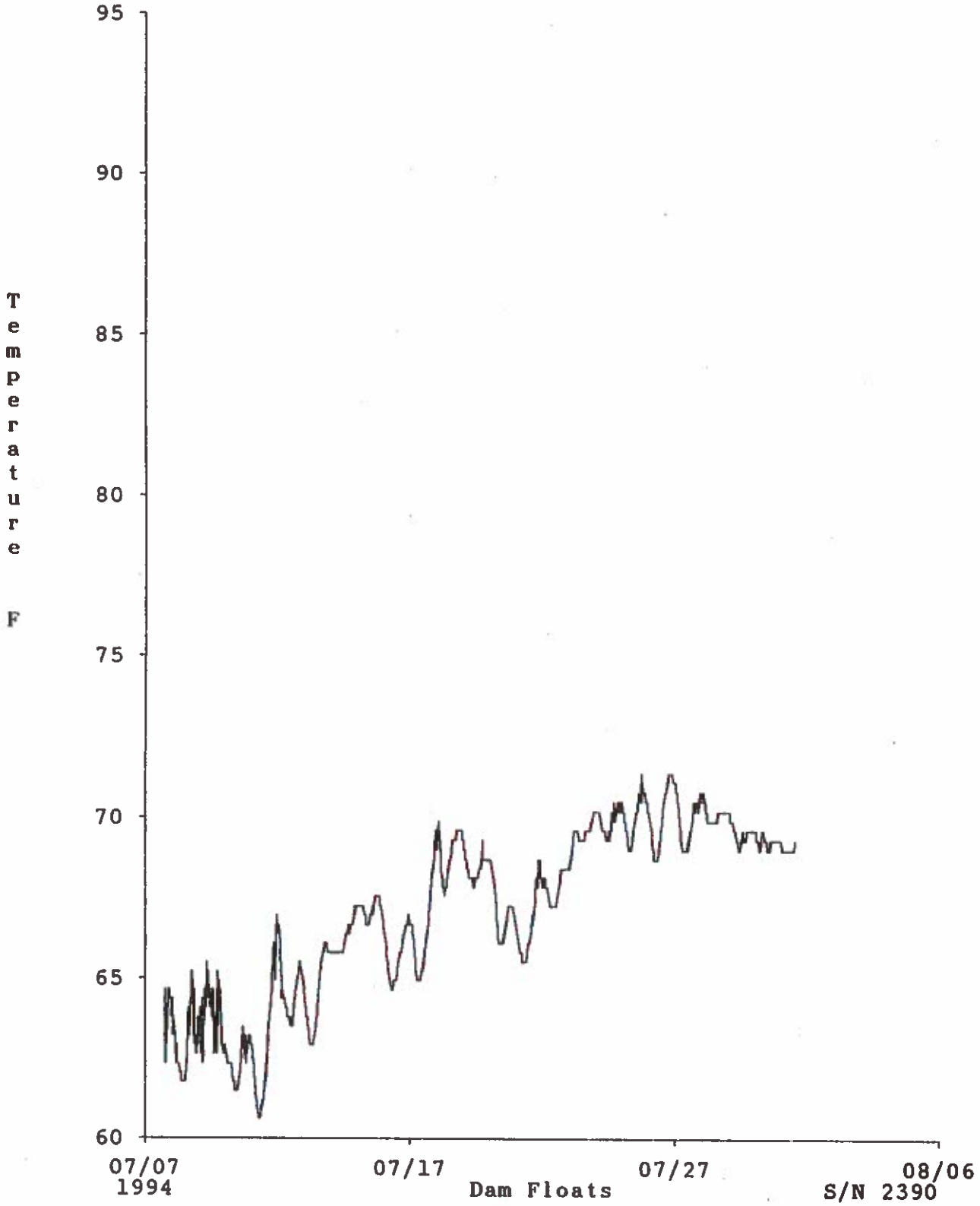
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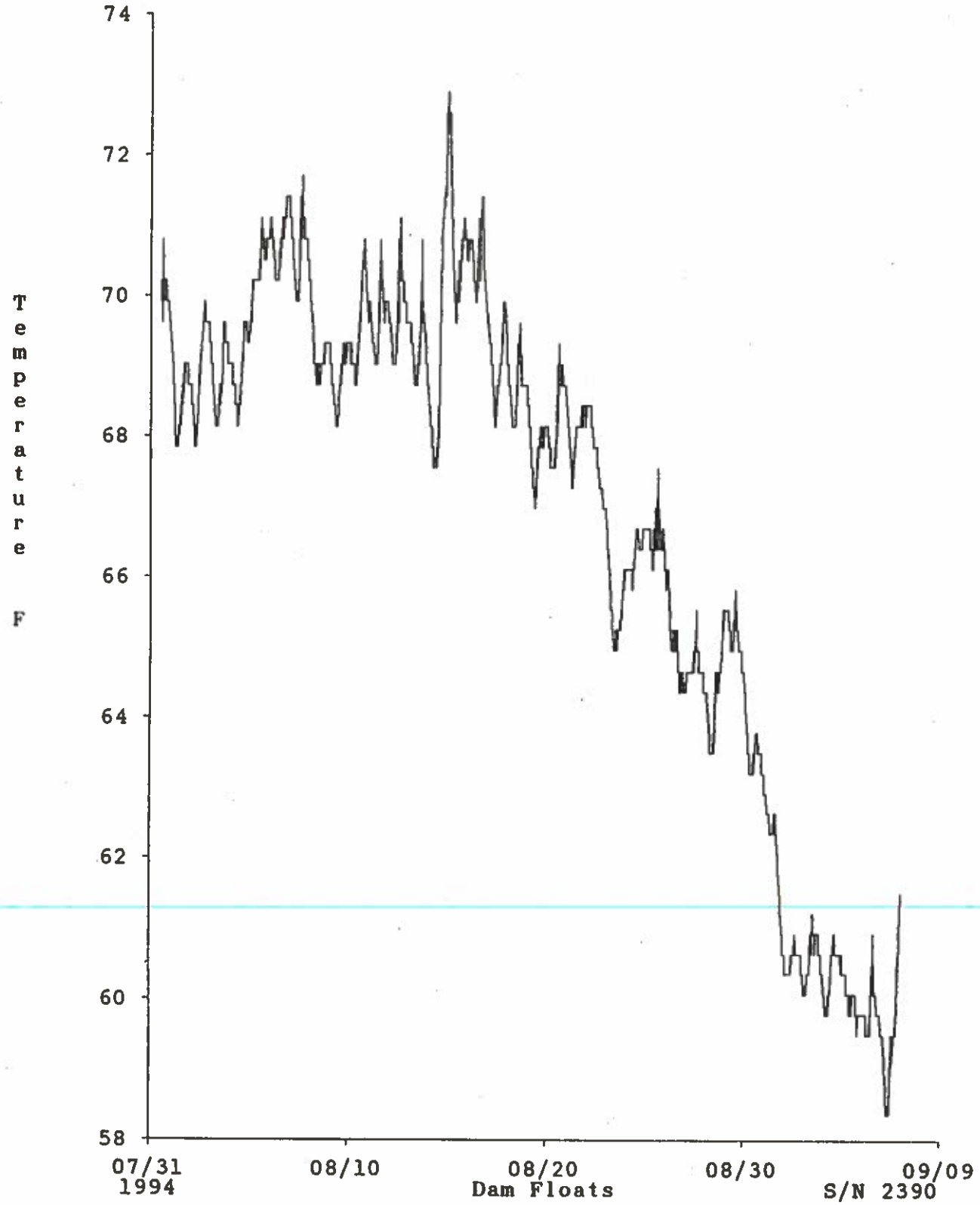
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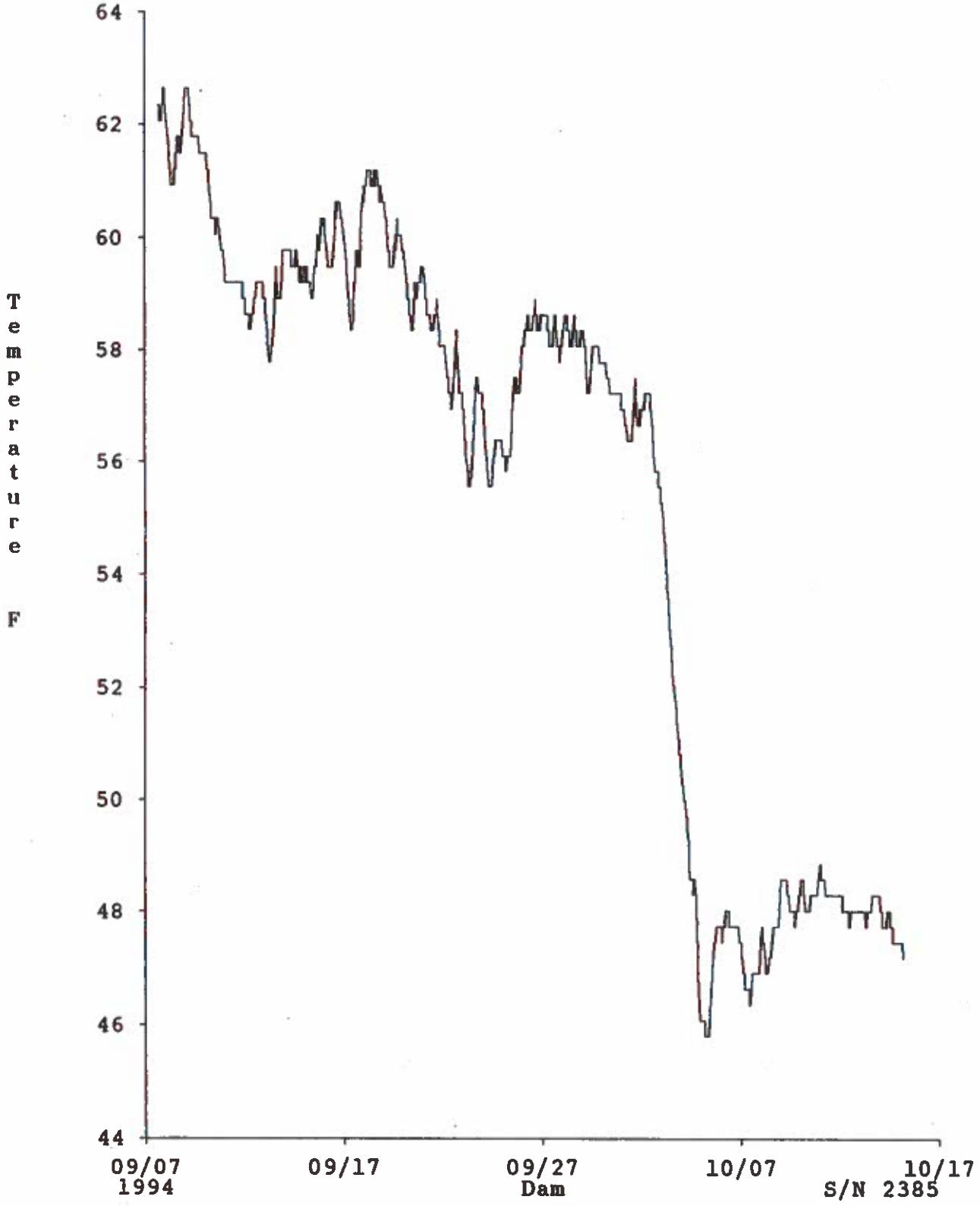
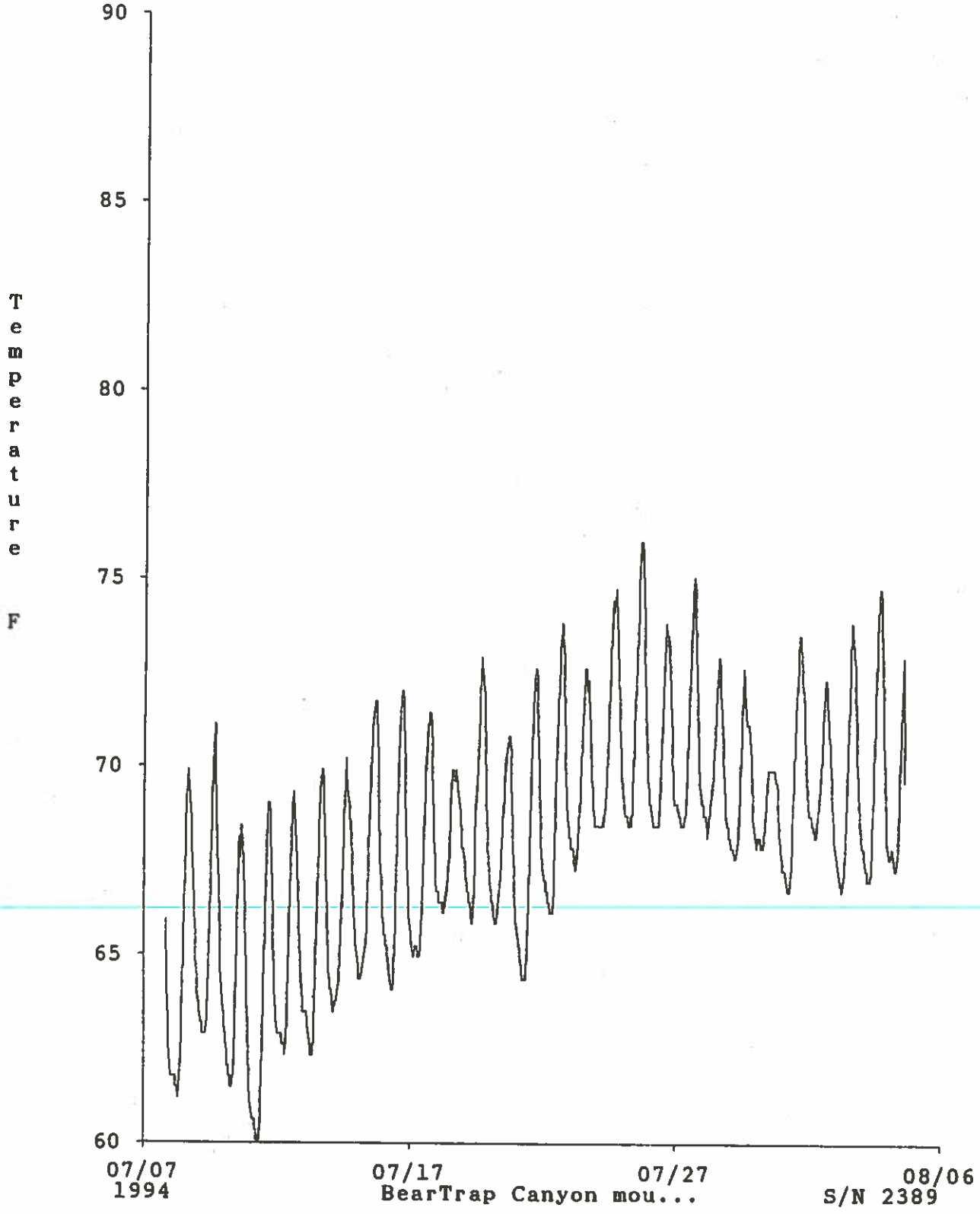
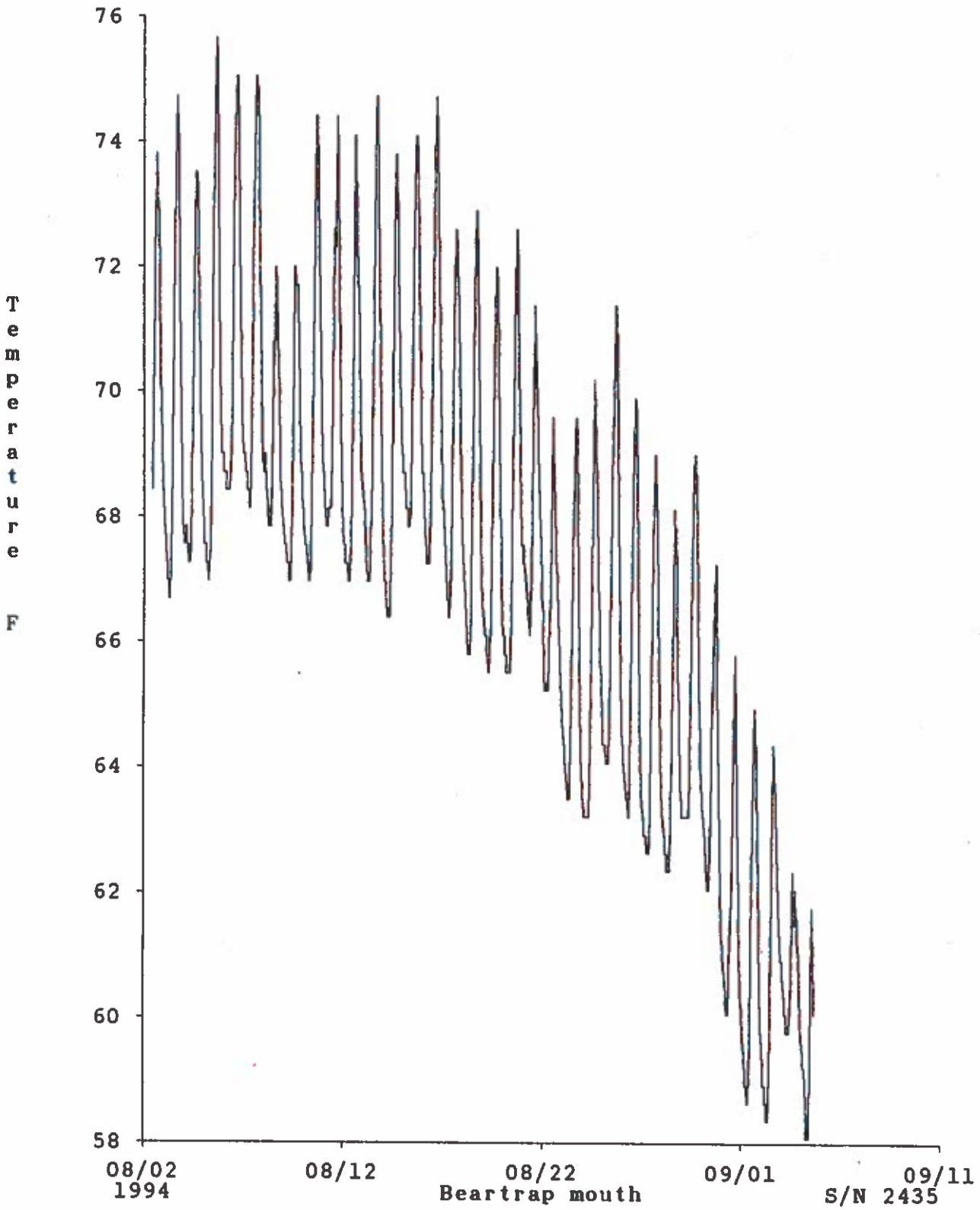
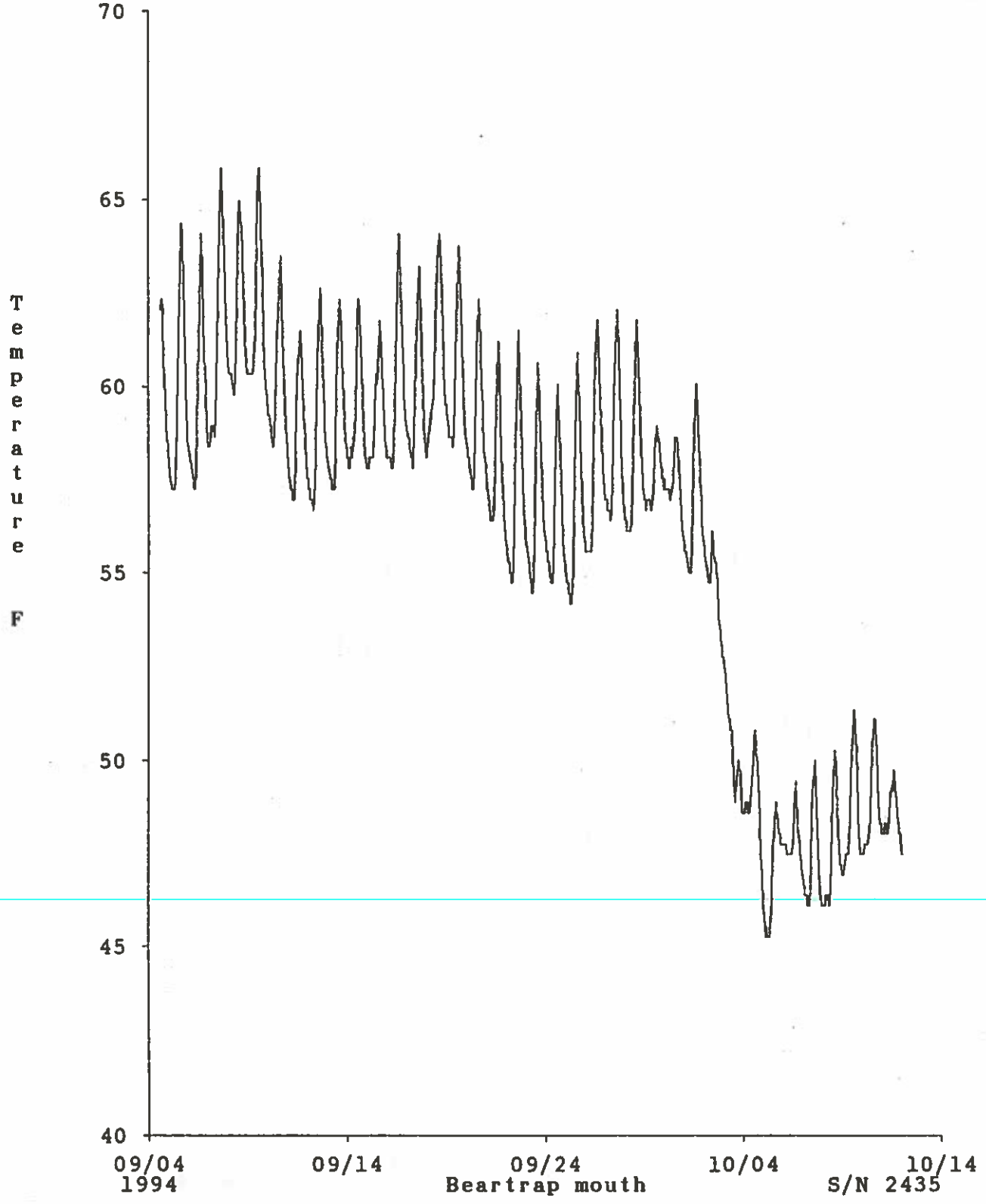
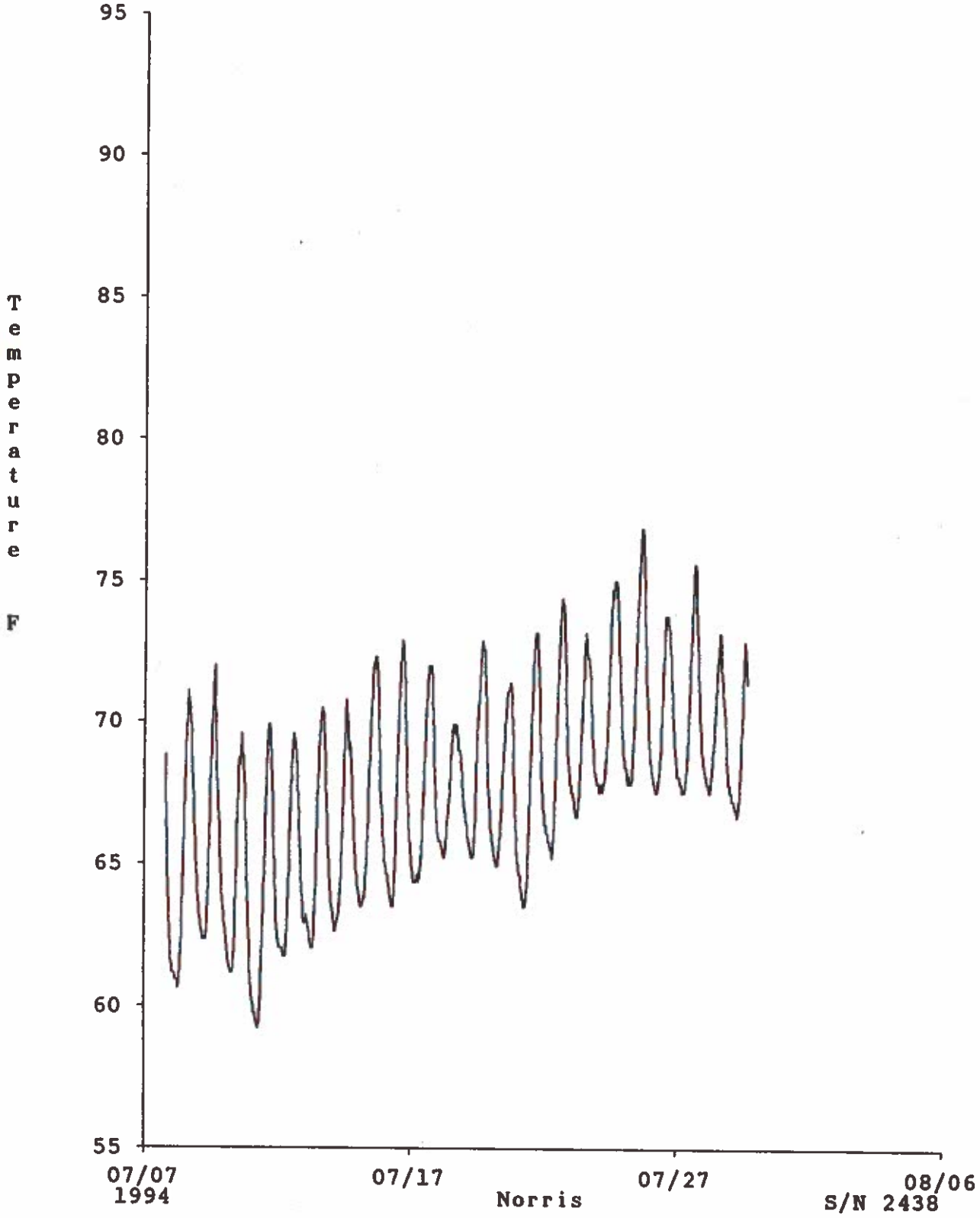
72
70
68
66
64
62
60
58
Temperature F
07/31
1994
08/10
08/20
Dam Floats
08/30
09/09
S/N 2390

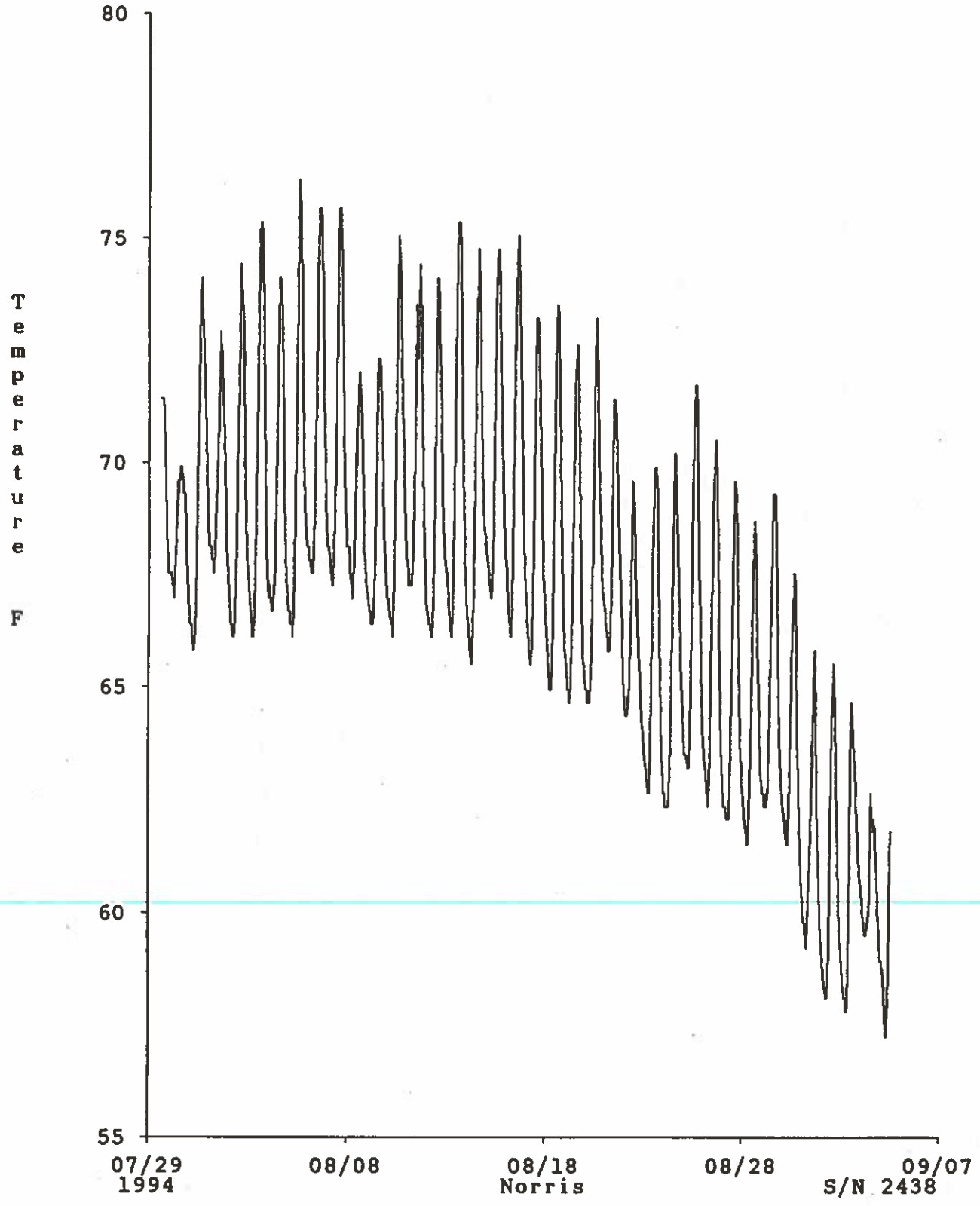

64
62
60
58
56
54
52
50
48
46
44
Temperature F
09/07
1994
09/17
09/27
Dam
10/07
10/17
S/N 2385

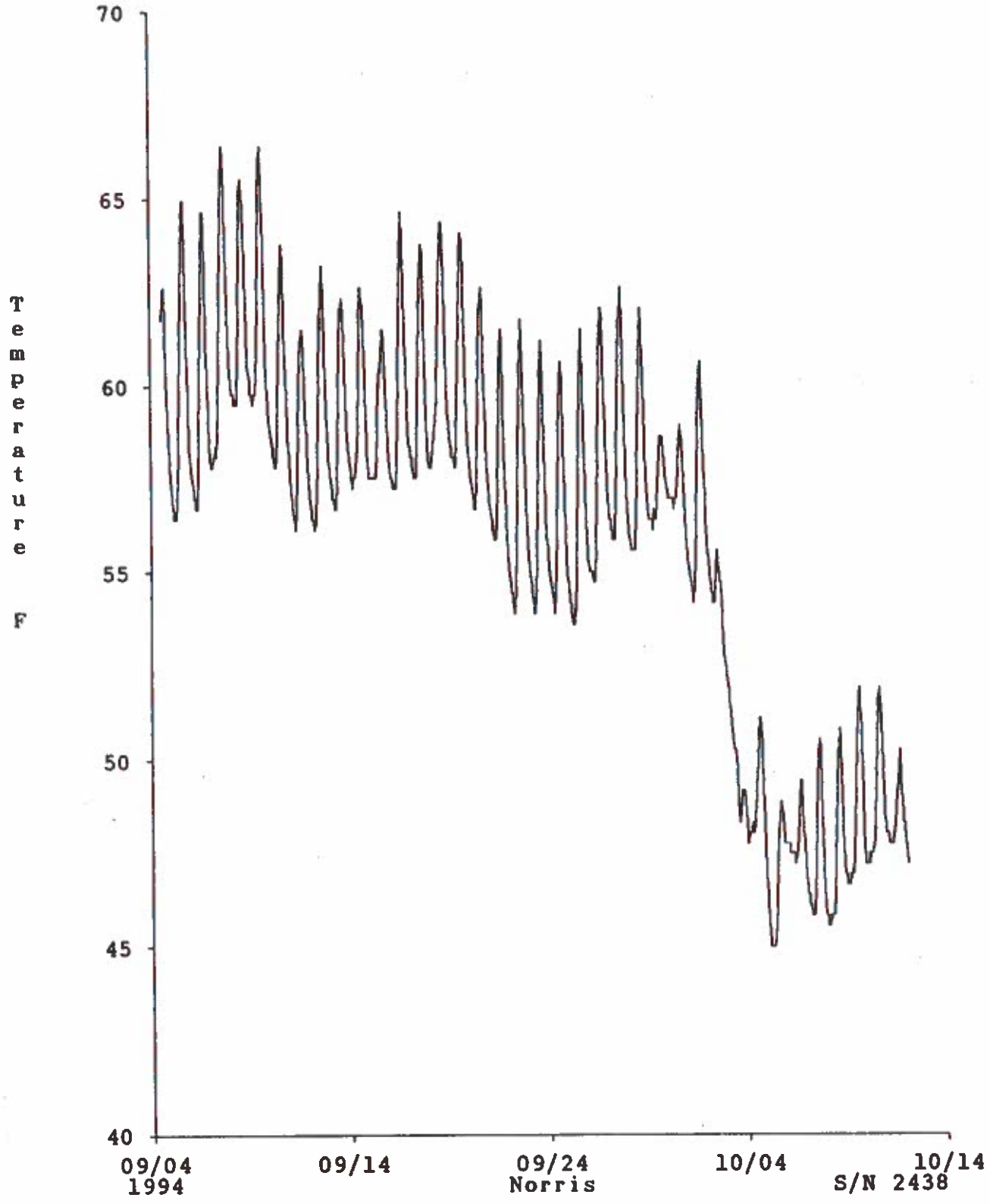

90
85
80
75
70
65
60
Temperature F
07/07
1994
07/17
07/27
08/06
BearTrap Canyon mou...
S/N 2389

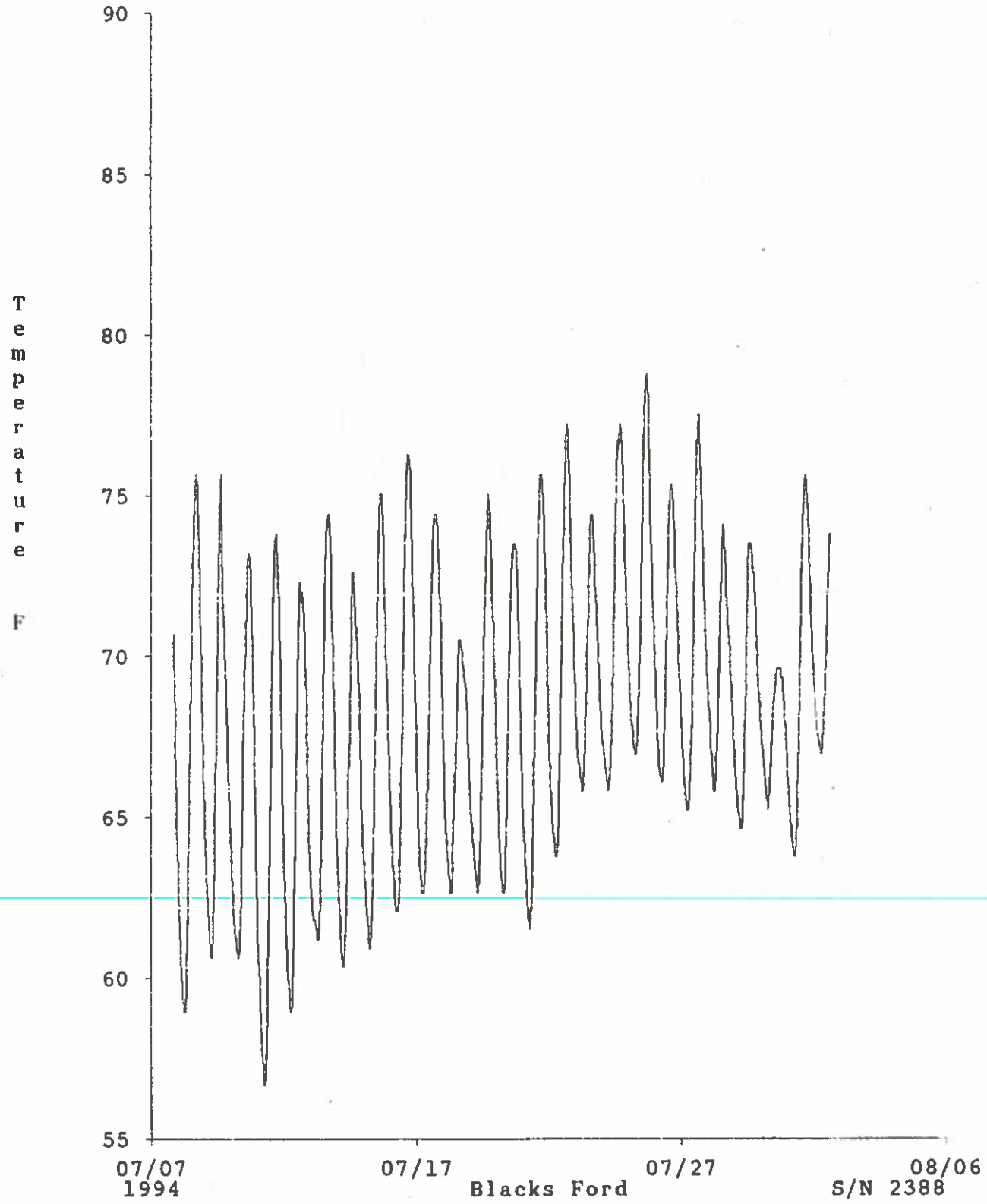

76
74
72
70
68
66
64
62
60
58
Temperature F
08/02
1994
08/12
08/22
09/01
09/11
Beartrap mouth
S/N 2435

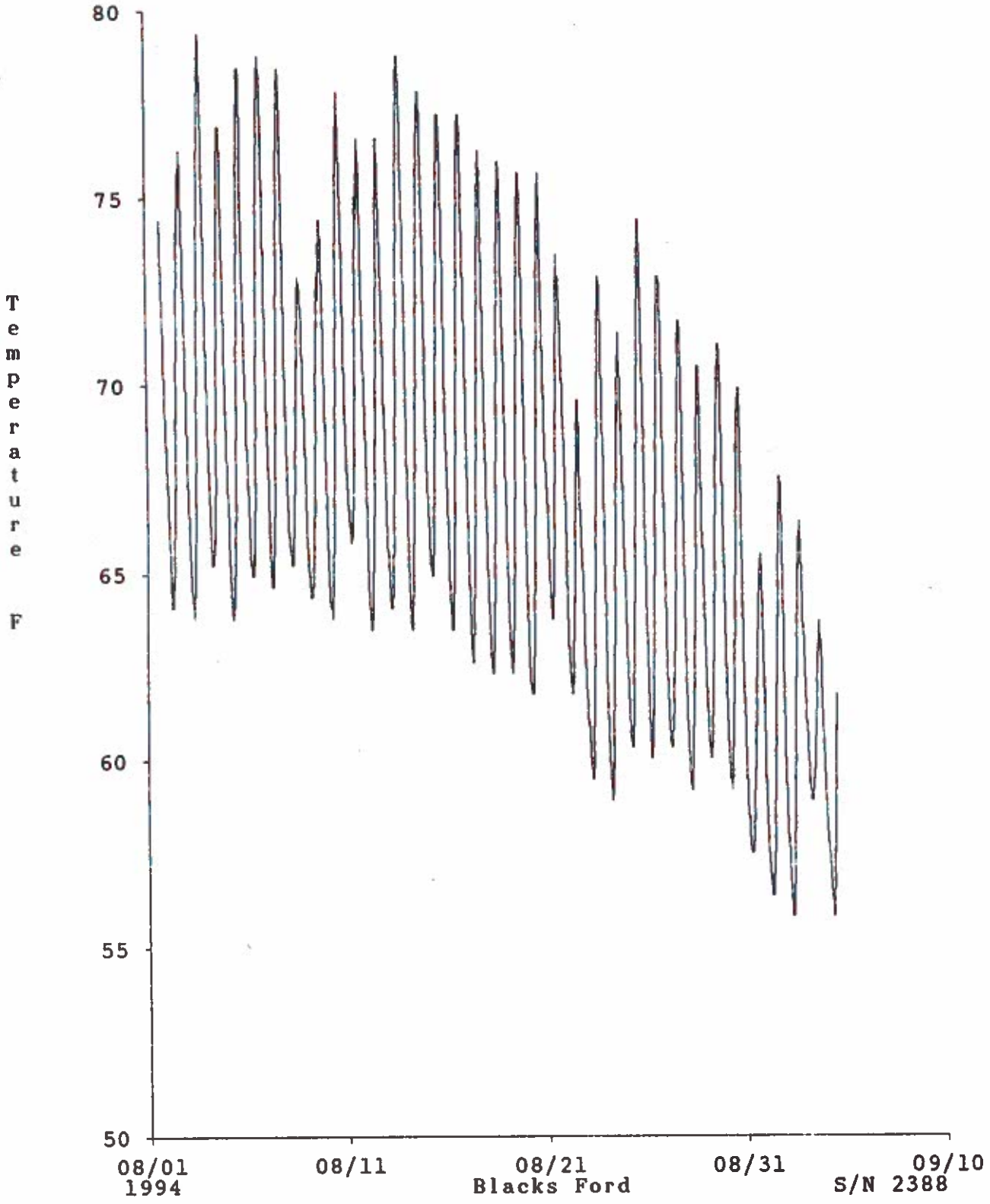

70
65
60
55
50
45
40
Temperature F
09/04
1994
09/14
09/24
Beartrap mouth
10/04
10/14
S/N 2435

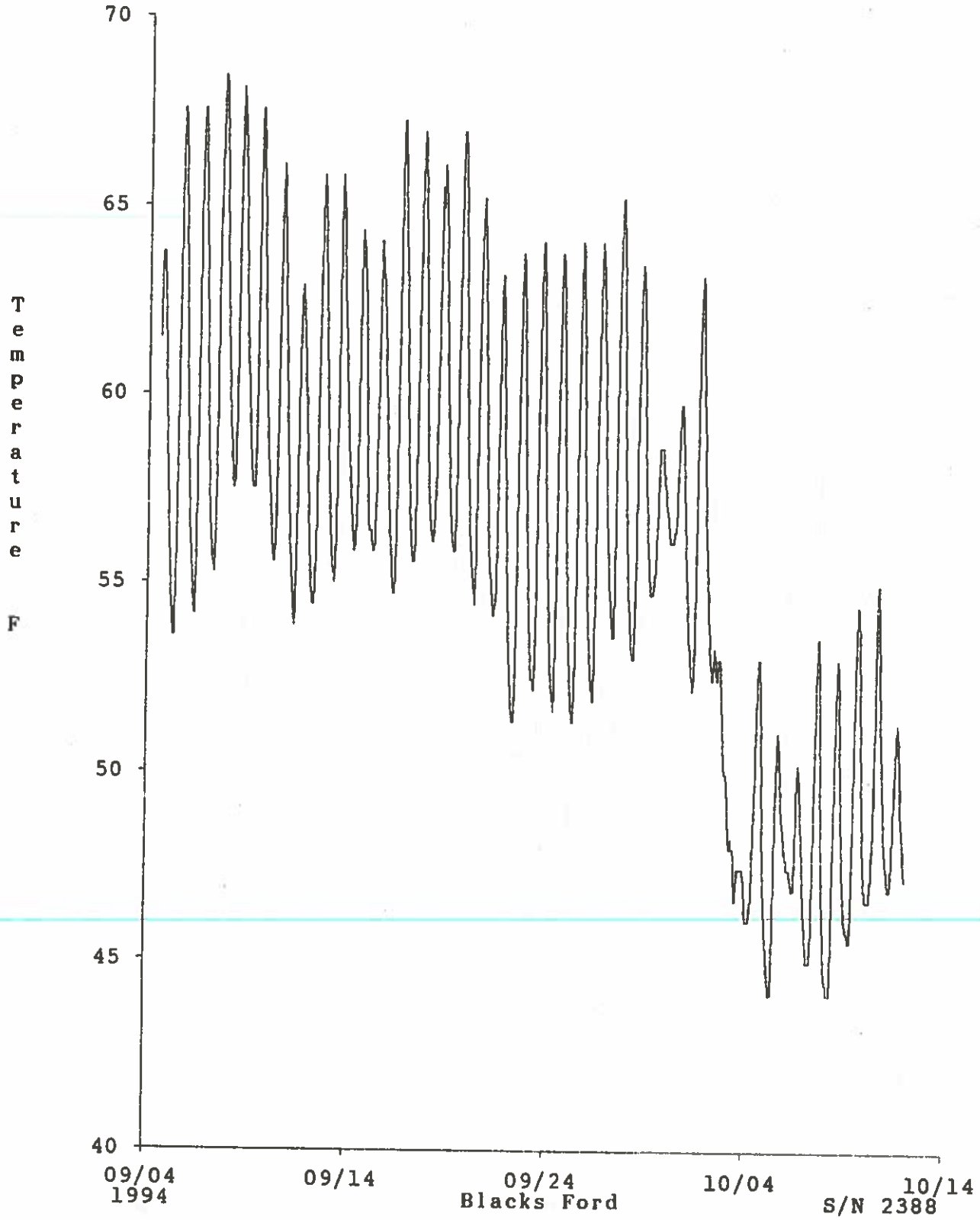

95
90
85
80
75
70
65
60
55
Temperature F
07/07
1994
07/17
07/27
08/06
Norris
S/N 2438

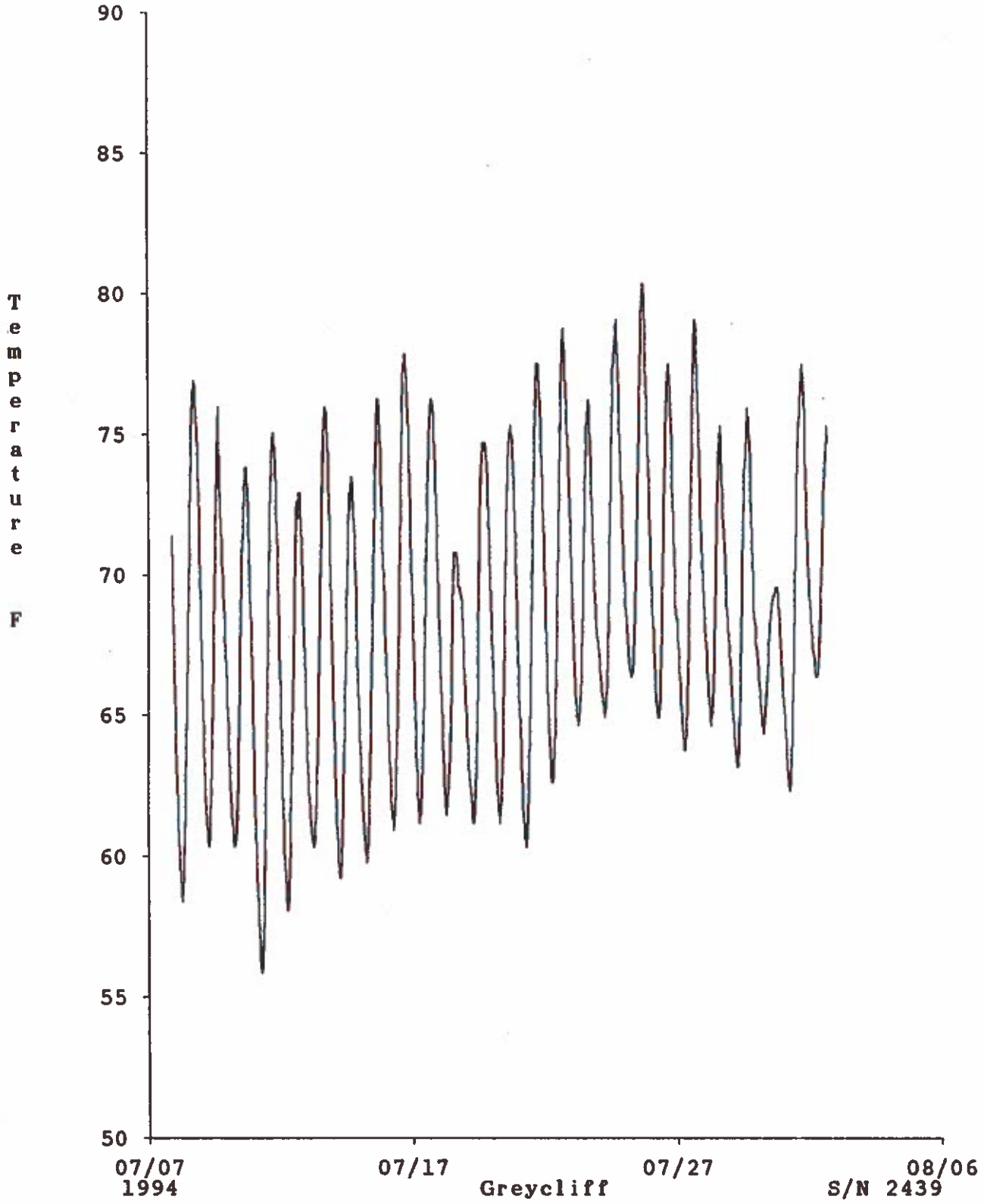

80
75
70
65
60
55
Temperature F
07/29
1994
08/08
08/18
Norris
08/28
09/07
S/N 2438

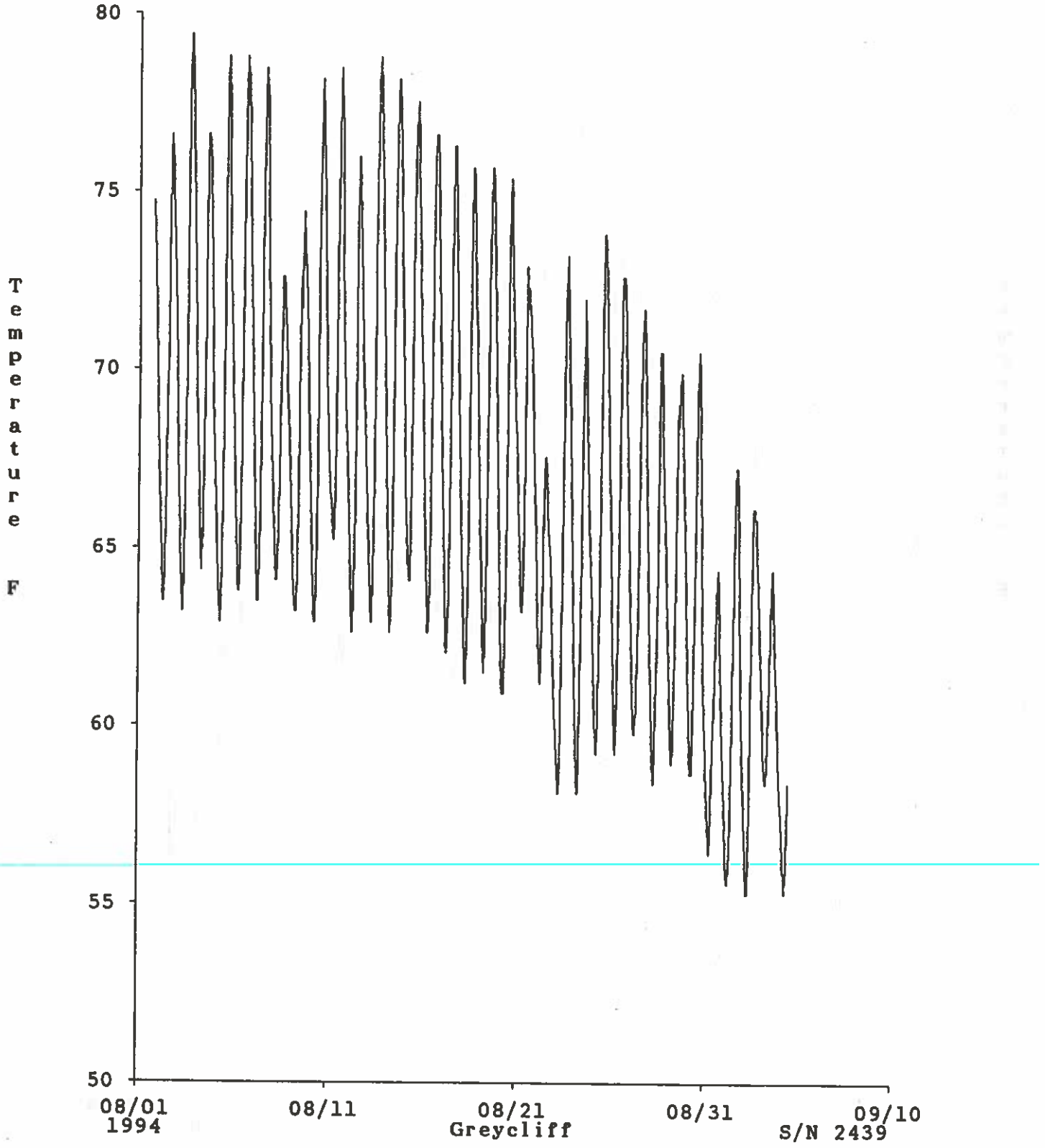

70
65
60
55
50
45
40
Temperature F
09/04
1994
09/14
09/24
Norris
10/04
10/14
S/N 2438

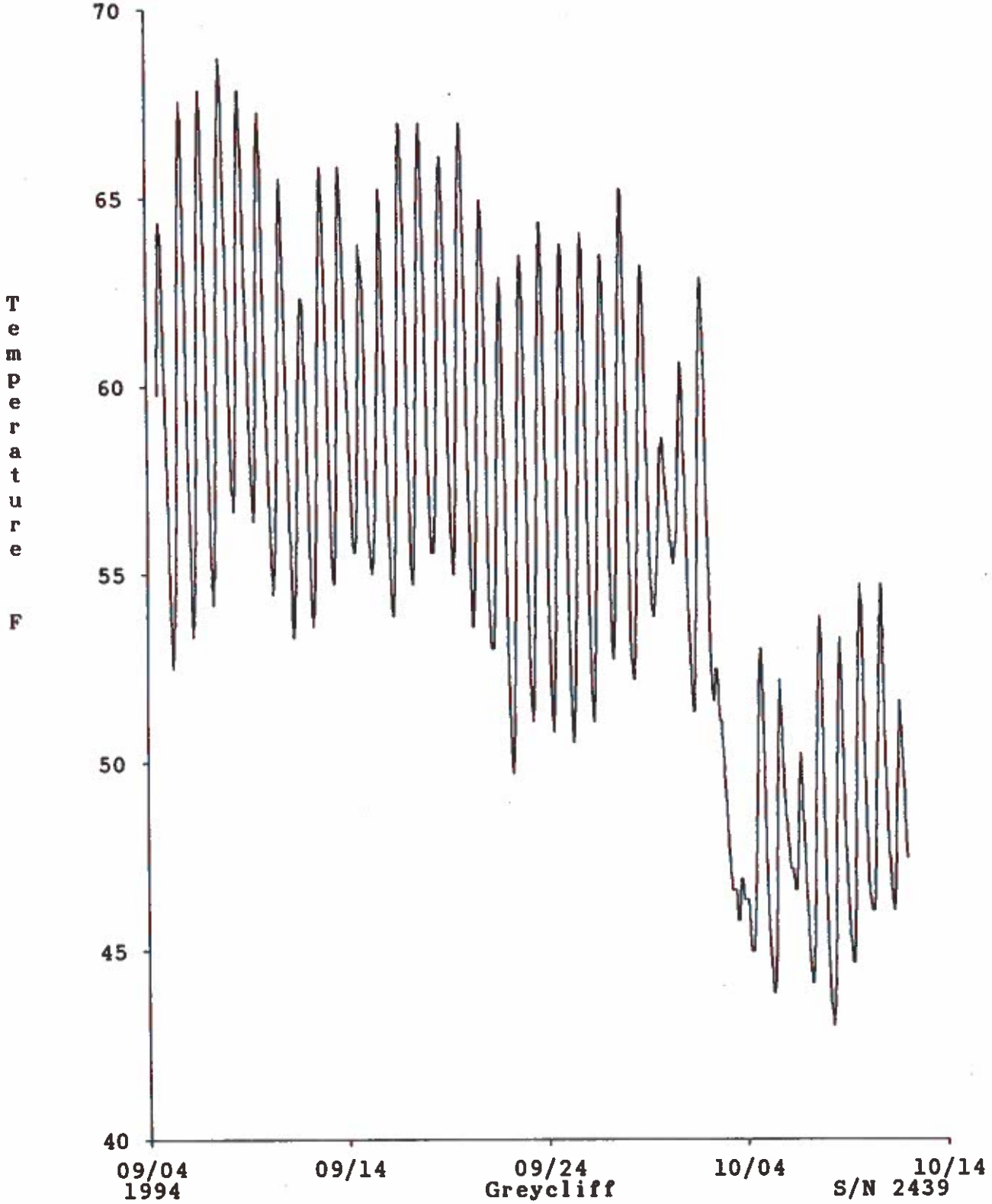

90
85
80
75
70
65
60
55
Temperature F
07/07
1994
07/17
07/27
08/06
Blacks Ford
S/N 2388


80
75
70
65
60
55
50
Temperature F
08/01
1994
08/11
08/21
Blacks Ford
08/31
09/10
S/N 2388


70
65
60
55
50
45
40
Temperature F
09/04
1994
09/14
09/24
Blacks Ford
10/04
10/14
S/N 2388


90
85
80
75
70
65
60
55
50
Temperature F
07/07
1994
07/17
07/27
08/06
Greycliff
S/N 2439


80
75
70
65
60
55
50
Temperature F
08/01
1994
08/11
08/21
Greycliff
08/31
09/10
S/N 2439


70
65
60
55
50
45
40
Temperature F
09/04
1994
09/14
09/24
Greycliff
10/04
10/14
S/N 2439