Environmental Protection Report

EAST DEVON PUBLIC WATER SUPPLY STRATEGY

EXE FRESHWATER MODEL – QUASAR VALIDATION/CALIBRATION

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EXE FRESHWATER MODEL

FOREWORD

The Water Quality function has to assess their response to the determination of abstraction licence applications on the basis that the proposed water resources development does not cause deterioration in water quality (if at all) of more than 10% This effect is defined using key appropriate determinands for the affected inland water or ground water. Large developments affecting almost the whole of a major river system are assessed using a water quality simulation model - QUASAR.

A licence application for a Wimbleball Pumped Storage Scheme was received in January 1993.

The generic QUASAR model requires ...

- o a design, setting out the physical representation of the river
- o calibrating, using a quality controlled data set; and
- o a proposed scenario(s) for modelling.

Three associated reports describe these three processes for the assessment of the Wimbleball Pumped Storage Scheme proposal.

These three reports are...

RP-NRA 1981AA_1001 (01) Quasar model design

RP-NRA 1981AA_1002 (01) Quasar validation/calibration

RP-NRA 1981AA_1004 (01) Wimbleball pumped storage scheme scenario modelling

This foreword is at the front of each of these separate reports to place them in context with one another.

Alan Weston
Water resources planning officer

EXECUTIVE SUMMARY

* A model of the River Exe has been constructed. In it the river is divided into 16 reaches from Wimbleball reservoir to Trews Weir, Exeter. The model design is described in NRA document, " Exe Freshwater Model - QUASAR Model Design" (ref. NRA-RP 1981AA-1002 (01)).

* The model has been designed to allow the future simulation of the operation of the Wimbleball Pump Storage Scheme proposed by South West Water Services Ltd.

* This document describes the calibration and validation of the model.

* River flow and water quality data from 1989 are used for calibration and 1990 data are used for validation.

* The overall error between the modelled and sampled water quality data is 26 per cent for 1989 and 21 per cent for 1990. This error is found by averaging over all monitoring sites for the following determinands; pH, temperature, BOD, nitrates, ammonia, dissolved oxygen.

* This is an acceptable error given the errors normally associated with water quality sampling.

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to describe the Calibration and Validation of the water quality river model, QUASAR, applied to the River Exe. The model will be used to help assess the environmental impact of the Wimbleball Pump Storage Scheme proposed by SWWSL.

1.2 Audience

The audience is :

NRA South West
East Devon Public Water Supply Strategy Coordination Group

1.3 Scope

The validation/calibration is for the QUASAR water quality model for the River Exe, described in NRA document, Exe Freshwater Model-QUASAR Model Design, 1992 (ref. NRA-RP 1981AA-1002 (01)).

1.4 List of Abbreviations

The document contains the following abbreviations:

NRA	:	National Rivers Authority
SWWSL	:	South West Water Services Ltd.
QUASAR	:	Quality Simulation Along a River
BOD	:	Biochemical Oxygen Demand
DO	:	Dissolved Oxygen
DMF	:	Daily Mean Flow

2 METHODOLOGY

2.1 Data

Two years of data are available, 1989 and 1990. The model has been calibrated using the 1989 data. Once a reasonable fit had been established then 1990 data was used as validation (see Appendix G for data values).

2.2 Approach

The first aspect of the model calibrated was the flow. Flow calibration had to be acceptable before the other water quality parameters could be checked.

Having calibrated the flows, the temperature and pH profiles were calibrated.

This procedure then ensured that the simulation of the 'environment' was valid before the interacting water quality determinands were checked.

2.3 Water Chemistry

The interacting determinands, which are :

- Dissolved Oxygen
- Biochemical Oxygen Demand
- Nitrate
- Ammonia

were then examined.

Their concentrations depend on the reaction decay rates, which were subjected to sensitivity testing, described in Section 7.1.

2.4 Comparative Profiles

For each of the above determinands, annual profiles, for 1989 and 1990, have been produced. These profiles show modelled values compared with the spot samples from the Water Quality Archive. The profiles are for reaches where sample data were available;

- Pixton
- Halfpenny Bridge
- Tiverton
- Collipriest
- Ashley
- Thorverton
- Stafford Bridge
- Trews Weir

2.5 Error Quantification

The differences between the modelled and observed values were quantified by calculating the percentage errors.

$$\text{error} = \sum_{1}^{n} \frac{\text{ABS}\,(X_{obs} - X_{mod})}{X_{mod}} \Big/ n \quad \times 100$$

3 FLOW

3.1 Hydrographs

Hydrographs generated by the model were compared with those based on the DMFs at the following gauging stations:

Stoodleigh
Thorverton

The hydrographs are shown in figures in Appendix A.

The figures show that the model replicates the main features of the DMF hydrograph.

The flow data used as input to the model were supplied by Watson Hawksley, consultants to SWWSL. The methodology used to generate these data was approved by the hydrology sub-group of the East Devon Water Resources Scheme Group. The methodolgy is described in the document:

East Devon Water Resources, Wimbleball Pumped Storage Scheme, Water Resources Appendix, Water Resources Model: Calibration and Development, A6, (ref RP-PLA-1981-034(01))

This supercedes the provisional approach descibed in section 3.3 of the document, Exe Freshwater model - QUASAR Model design (ref. NRA-RP 1981AA-1002 (01)).

4 TEMPERATURE

4.1 Profiles

The figures in Appendix B compare the model and archive temperature data at the sampling points.

The comparison is reasonable.

4.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	30.05	7.39
Halfpenny	9.70	17.52
Tiverton	11.38	11.65
Collipriest	10.10	17.94
Ashley	18.50	16.68
Thorverton	23.03	16.49
Stafford Br.	14.18	12.29
Exwick	14.39	11.96
Trews Weir	23.33	20.31
All Sites	17.18	14.69

5 pH

5.1 Profiles

The figures in Appendix C compare the model and archive pH profiles at the sampling points.

The comparison is reasonable.

5.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	1.56	0.83
Halfpenny	0.74	1.19
Tiverton	1.85	1.45
Collipriest	2.99	4.68
Ashley	2.39	3.67
Thorverton	2.16	1.85
Stafford Br.	1.95	1.90
Exwick	3.34	3.76
Trews Weir	3.37	3.08
All Sites	2.26	2.49

6 WATER CHEMISTRY

6.1 Introduction

The concentrations of :

- Dissolved Oxygen
- Biochemical Oxygen Demand
- Ammonia
- Nitrate

are interdependent.

They depend upon the following reactions :

- BOD decay
- nitrification
- denitrification
- DO reaeration and other production/loss processes

There is a consensus amongst modellers for the range of values for the BOD, nitrification and denitrification rates. Consequently, values within the generally accepted range were used (ref. QUASAR Theory Manual, Institute of Hydrology, 1992)

The following values were settled upon :

- BOD decay rate 0.150 /day
- denitrification 0.050 * 10**(0.0293T+0.0294) /day
  where T = temperature
- nitrification 0.250 * 10**(0.0293T+0.0294) /day
  above Thorverton
  0.050 * 10**(0.0293T+0.0294) /day
  below Thorverton

6.2 Biochemical Oxygen Demand

6.2.1 Profiles

The figures in Appendix D compare the model and archive BOD profiles at the sample points.
The modelled and sample results are similar.

6.2.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	25.18	50.62
Halfpenny Bridge	14.41	34.71
Tiverton	34.73	30.80
Collipriest	26.00	28.18
Ashley	53.98	32.64
Thorverton	44.71	29.08
Stafford Bridge	29.12	27.70
Exwick	(128.25)	36.52
Trews Weir	45.91	45.33
All Sites	34.26	35.06

The BOD archive data set has a large variance which is reflected in the percentage errors.

Discrepancies in the BOD profiles below Tiverton were identified to be associated with large model input loadings from Heathcoats Dye Works. Originally the Heathcoats abstraction and discharge were set at the maximum consented values of 0.042 cumecs. Following discussions with Abstraction Licensing section of NRA South West it became clear that the actual abstractions were less then the consented values. Consequently the inputs from Heathcotes were treated as calibration variables. As a simplification the flow quantities were modified to bring the model into agreement with the observations. It is not implied that the values for flow used are correct, but that the net loadings (which are the product of flow and concentrations) below the initial mixing/loss zone are more realistic.

6.3 Nitrates

6.3.1 Profiles

The figures in Appendix E compare the model and archive nitrate profiles at the sample points.
The modelled and sample results are similar.

6.3.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	31.41	19.23
Halfpenny Bridge	14.09	17.93
Tiverton	18.16	23.52
Collipriest	36.59	30.26
Ashley	15.88	14.62
Thorverton	24.25	26.70
Stafford Bridge	12.84	23.91
Exwick	25.72	10.66
Trews Weir	13.52	17.70
All Sites	21.38	20.50

6.4 Ammonia

6.4.1 Profiles

The figures in Appendix F compare the model and archive ammonia profiles at the sample points.

The comparison for most points is reasonable, given that the values are so small and close to the instrument resolution. The percentage errors do not reflect the reasonable overall fit because of outriders.

6.4.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	71.15	33.27
Halfpenny Bridge	41.09	25.54
Tiverton	45.34	26.88
Collipriest	47.12	87.09
Ashley	99.69	83.58
Thorverton	70.33	36.53
Stafford Bridge	98.91	38.94
Exwick	(333.48)	42.81
Trews Weir	91.73	44.76
All Sites	70.67	46.60

The large discrepancy at Trews Weir appears to be due to diffuse inputs between Exwick and Trews Weir that were not modelled. This is evident by comparison of the observations at these two sites where Trews Weir values are higher than those at Exwick.

6.5 Dissolved Oxygen

6.5.1 Profiles

The figures in Appendix G compare the model and archive DO profiles at the sample points.
The modelled and sample results are similar.

6.5.2 Percentage Errors

The percentage errors were:

	1989	1990
Pixton	4.75	4.36
Halfpenny Bridge	8.65	4.81
Tiverton	16.19	3.64
Collipriest	6.72	6.00
Ashley	9.05	6.65
Thorverton	7.88	7.42
Stafford Bridge	12.07	7.54
Exwick	13.25	18.72
Trews Weir	6.55	8.64
All Sites	9.46	7.53

There is a consensus for the DO reaeration rate, although the range of acceptable values is very large. Consequently the value supplied by IH was used. This value gave a reasonable agreement with the archive data, except during June to August below Thorverton. During these months there is a biomass loading which requires oxygen from the river thereby reducing the DO concentration. The model allows for the concentration of dead algae and their respiration rate to be set. By so doing the modelled DO concentrations are reduced during these months giving a reasonable fit with the data.
The values for June to August at Thorverton to Exwick were:

Dead algae conc.	20.00 mg/l
Respiration offset	0.25
Respiration slope	0.25 /day

7 SUMMARY ERRORS

7.1 Overall Percentage Errors

The percentage error for the model:

1989	1990
25.87	21.15

This overall percentage error is formed by averaging the percentage errors over all sites and all six evaluated determinands (pH,Temperature,BOD,Nitrates, ammonia,DO).

The percentage error for the water chemistry:

1989	1990
33.94	27.42

This percentage error for the water chemistry is formed by averaging the percentage errors over all sites and four determinands (BOD,Nitrates,Ammonia,DO).

The spot sample water quality data used in forming these statistics are listed in Appendix H.

8 FIELD VALIDATION

8.1 Survey Data

A field survey of the River Exe was carried out in March 1992, consisting of water quality spot samples taken at various points down the river and of discharges and tributaries taking into account time of travel data. Results are given in the following tables. These data were intended to give a 'snap-shot' picture of the river and although the values cannot be strictly related to the model they show the underlying trends down the river system. The data are shown overleaf.

0 Site	1	2 Date	3 Time	4 pH	5 Cond	6 Temp	7 DO %sat	8 DO	9 BOD	10 Carbon	11 Cod	12 Amm N	13 Nitrogen
1 D/S Wim	RPL/05G	03-MAR-92	08:00:00	7.8	131	8.6	104	12.10	1.0	1.3	...	0.02	2.5
2 R Pulham	R05G009	03-MAR-92	08:00:00	7.7	127	6.8	97	11.80	1.2	1.1	...	0.02	3.3
3 Hort FF	P05G/P/2	03-MAR-92	08:13:00	7.3	84	8.3	81	9.51	3.4	1.0	...	0.27	2.8
4 Pixy Cop	R05G005	03-MAR-92	10:40:00	7.7	135	7.7	99	11.80	1.0	1.2	...	0.04	2.7
5 Weir Hse	RPL/05g	03-MAR-92	10:40:00	7.7	129	7.0	98	11.90	1.0	0.9	...	0.02	1.9
6 R Barle	R05H003	03-MAR-92	10:57:00	7.8	85	7.1	97	11.70	1.0	0.9	...	0.02	1.0
7 Pixton	R05G003	03-MAR-92	11:10:00	7.8	130	7.4	99	11.90	1.0	0.9	...	0.02	2.2
8 Exe Val FF	P05E/P/12	03-MAR-92	12:03:00	7.4	113	7.1	79	9.55	2.0	1.1	...	0.22	1.8
9 Exebridge	R05E001	03-MAR-92	12:17:00	7.8	104	7.5	97	11.60	1.0	1.0	...	0.03	1.5
10 R Brockey	R05E012	03-MAR-92	12:24:00	7.8	201	7.5	100	12.00	1.0	1.4	...	0.02	2.2
11 Highleigh FF	P05E/P/61A	03-MAR-92	13:00:00	7.7	114	7.5	90	10.80	1.9	1.2	...	0.20	1.6
12 Oakford B	RPL/05E	03-MAR-92	13:50:00	7.8	110	7.5	98	11.70	1.1	1.0	...	0.06	1.6
13 Rainbow FF	P05E/P/61	03-MAR-92	14:11:00	7.3	118	7.5	98	11.70	3.1	4.2	...	0.39	1.4
14 Rainbow FF	P05E/P/61B	03-MAR-92	14:15:00	7.6	235	7.4	78	9.36	3.0	1.1	...	0.36	1.5
15 Iron Mill	R05E008	03-MAR-92	14:11:00	7.8	244	7.2	98	11.80	1.1	1.2	...	0.02	2.4
16 Halfpenny	R05E002	03-MAR-92	14:14:00	7.7	116	8.0	99	11.70	1.3	1.1	...	0.08	1.7
17 R Batherm	R05F003	03-MAR-92	16:25:00	7.8	250	8.3	99	11.60	1.1	1.2	...	0.03	2.3
18 SS943178	RPL/05F	03-MAR-92	20:55:00	7.7	133	7.9	90	10.70	1.0	0.9	...	0.06	1.9
19 Lythecourt	R05E003	03-MAR-92	23:35:00	7.7	136	7.7	94	11.20	1.3	0.9	...	0.06	2.0
20 Bolham Last	R05E033	03-MAR-92	23:50:00	7.6	132	7.7	97	11.60	2.5	1.6	...	0.10	2.0
21 Calverleigh	R05E020	04-MAR-92	00:15:00	7.9	271	6.4	102	12.50	1.3	1.8	...	0.06	6.2
22 Tiverton	R05E004	04-MAR-92	01:00:00	7.9	133	7.3	100	12.00	1.0	1.0	...	0.05	2.1
23 Heathcoats	R05E/P/36	04-MAR-92	01:20:00	8.3	3417	16.8	56	5.39	50.0	65.0	...	0.48	2.9
24 R Lowman	RPL/05E	04-MAR-92	01:40:00	7.8	288	7.1	98	11.80	1.4	2.4	...	0.08	5.5
25 Collipriest	R05E005	04-MAR-92	02:15:00	7.8	104	7.2	97	11.70	1.0	1.3	...	0.05	2.9
26 Tiv STW	WSTW7788PE	04-MAR-92	03:02:00	7.2	550	10.3	69	7.71	15.7	10.5	...	1.50	21.0
27 Ashley	R05E006	04-MAR-92	04:00:00	7.7	168	7.1	100	12.10	1.5	1.1	...	0.05	2.6
28 R Dart	R05D007	04-MAR-92	05:30:00	7.8	206	5.9	99	12.30	1.0	2.0	...	0.04	5.2
29 Bickleigh	R05D015	04-MAR-92	06:00:00	7.7	174	6.8	101	12.30	1.5	1.3	...	0.04	2.9
30 R Durn	R05D008	04-MAR-92	07:20:00	7.7	275	5.7	98	12.30	1.0	2.1	...	0.13	8.4
31 Thorv STW	WSTW7784PE	04-MAR-92	10:10:00	7.4	502	...	...	...	8.8	6.2	...	0.75	29.0
32 Thorveton	R05D001	04-MAR-92	10:29:00	7.8	174	7.1	101	...	1.5	1.7	...	0.03	2.9
33 R Culm	RPL/05D	04-MAR-92	14:30:00	7.9	391	8.7	98	...	2.4	4.3	...	0.10	7.0
34 Bramp STW	WSTW7518PE	04-MAR-92	15:00:00	7.3	552	8.6	61	...	7.1	8.4	...	4.00	26.0
35 Pynes Intake	R05D012	04-MAR-92	14:23:00	8.1	179	7.6	113	...	2.7	2.0	...	0.02	3.0
36 Stafford Br	R05D002	04-MAR-92	16:07:00	8.1	229	7.9	109	...	1.8	2.1	...	0.03	4.0
37 R Creedy	...	04-MAR-92	17:02:00	7.9	327	7.9	101	12.00	2.1	3.3	...	0.11	7.0
38 Exwick	R05D003	04-MAR-92	17:40:00	8.0	245	8.0	104	12.30	1.8	2.5	...	0.05	4.7
39 Trows Weir	R05D004	04-MAR-92	20:35:00	7.9	246	7.9	107	12.70	2.2	2.8	...	0.04	4.7

0 Site	14 Nitrate	15 Nitrite	16 Unl Amm	17 SS	18 Nord	19 Alk pH4.5	20 Chlor ion	21 Ortho phos	22 Silicate dis	23 Sulphate
1 D/S Wim	2.47	0.01	0.0002	2.0	...	25	16	0.01	1.7	8.6
2 R Pulham	3.29	0.01	0.0001	3.6	...	21	15	0.02	3.2	7.6
3 Hort FF	2.79	0.01	0.0009	9.7	...	23	15	0.06	2.7	8.0
4 Pixy Cop	2.67	0.03	0.0003	3.0	...	26	15	0.05	3.1	8.0
5 Weir Hse	1.89	0.01	0.0001	2.0	...	31	14	0.01	3.4	6.7
6 R Barle	0.99	0.01	0.0002	2.0	...	12	12	0.01	3.1	5.6
7 Pixton	2.19	0.01	0.0002	2.0	...	27	14	0.03	3.3	7.5
8 Exe Val FF	0.99	0.01	0.0008	9.9	...	16	11	0.05	3.0	5.0
9 Exebridge	1.49	0.01	0.0003	2.0	...	20	13	0.02	3.2	5.3
10 R Brockey	2.19	0.01	0.0002	3.0	...	63	17	0.01	4.5	10.6
11 Highleigh FF	1.59	0.01	0.0015	3.6	...	25	13	0.06	3.4	6.4
12 Oakford B	1.59	0.01	0.0006	2.2	...	22	14	1.20	3.4	6.5
13 Rainbow FF	1.39	0.01	0.0012	11.0	...	19	13	0.11	3.2	1326.0
14 Rainbow FF	1.49	0.01	0.0022	10.0	...	24	14	0.07	3.3	6.3
15 Iron Mill	2.39	0.01	0.0002	9.8	...	76	20	0.02	6.7	15.3
16 Halfpenny	1.69	0.01	0.0006	3.5	...	22	13	0.04	3.7	7.0
17 R Bathorn	3.28	0.02	0.0003	5.7	...	80	21	0.12	4.2	12.7
18 SS943178	1.88	0.02	0.0005	3.5	...	30	15	0.02	3.3	7.5
19 Lythecourt	1.98	0.02	0.0005	2.0	...	31	15	0.03	3.2	7.5
20 Bolham Last	1.98	0.02	0.0006	3.5	...	31	15	0.03	3.2	7.8
21 Calverleigh	6.18	0.02	0.0007	13.0	...	73	27	0.05	6.0	11.4
22 Tiverton	2.08	0.02	0.0006	3.1	...	26	15	0.03	3.3	10.4
23 Heathcoate	2.27	0.23	0.0282	16.0	...	94	626	0.03	2.5	103.0
24 R Lowman	3.46	0.04	0.0007	11.0	...	98	23	0.05	6.0	14.8
25 Collipriest	2.87	0.03	0.0005	5.3	...	48	18	0.03	3.8	12.8
26 Tiv STW	20.80	0.20	0.0045	22.0	...	91	56	4.60	11.9	50.1
27 Ashley	2.58	0.02	0.0004	3.5	...	39	19	0.05	3.4	13.0
28 R Dart	5.17	0.03	0.0003	11.0	...	40	26	0.03	5.9	10.3
29 Bickleigh	2.88	0.02	0.0003	13.0	...	38	20	0.05	3.6	11.7
30 R Burn	8.33	0.07	0.0009	15.0	...	64	26	0.10	8.5	13.5
31 Thorv STW	24.80	0.22	...	13.0	...	48	50	6.10	15.7	46.8
32 Thorveton	2.88	0.02	...	2.9	...	31	19	0.06	3.5	12.3
33 R Culm	6.93	0.07	...	5.3	...	107	34	0.23	8.4	28.0
34 Bramp STW	25.50	0.45	...	13.0	...	62	61	7.20	9.8	51.4
35 Pynes Intake	2.98	0.02	...	3.9	...	32	19	0.07	3.5	12.4
36 Stafford Br	3.97	0.03	...	2.0	...	49	23	0.11	4.7	27.4
37 R Creedy	6.95	0.05	0.0014	6.7	...	72	39	0.24	9.3	16.7
38 Exwick	4.66	0.04	0.0008	5.1	...	59	25	0.11	5.7	16.7
39 Trews Weir	4.66	0.04	0.0005	13.0	...	64	25	0.12	5.7	16.9

Appendix A - Flow Profiles

Key

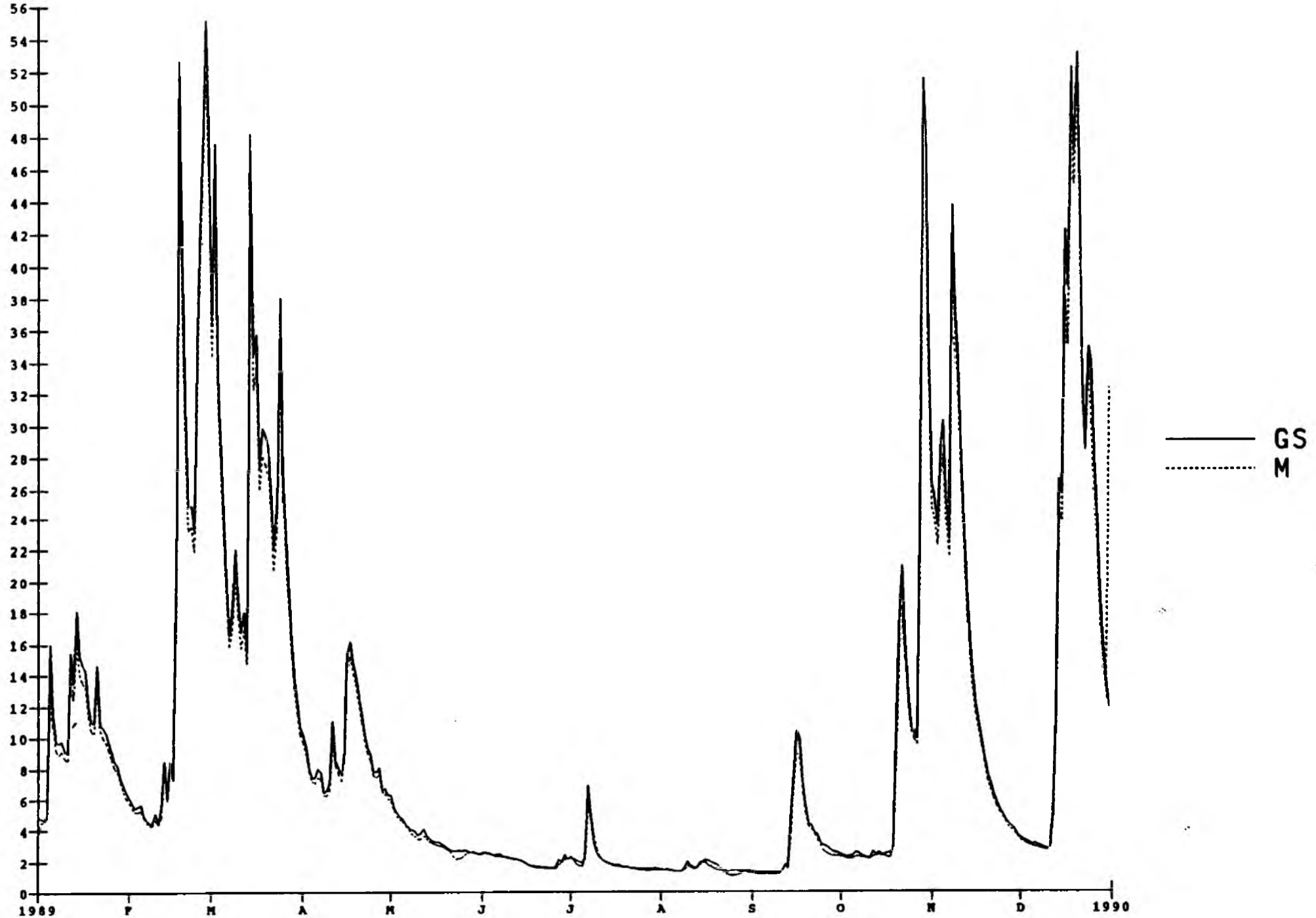
M = modelled flow
GS = observed flow at gauging station

Contents:

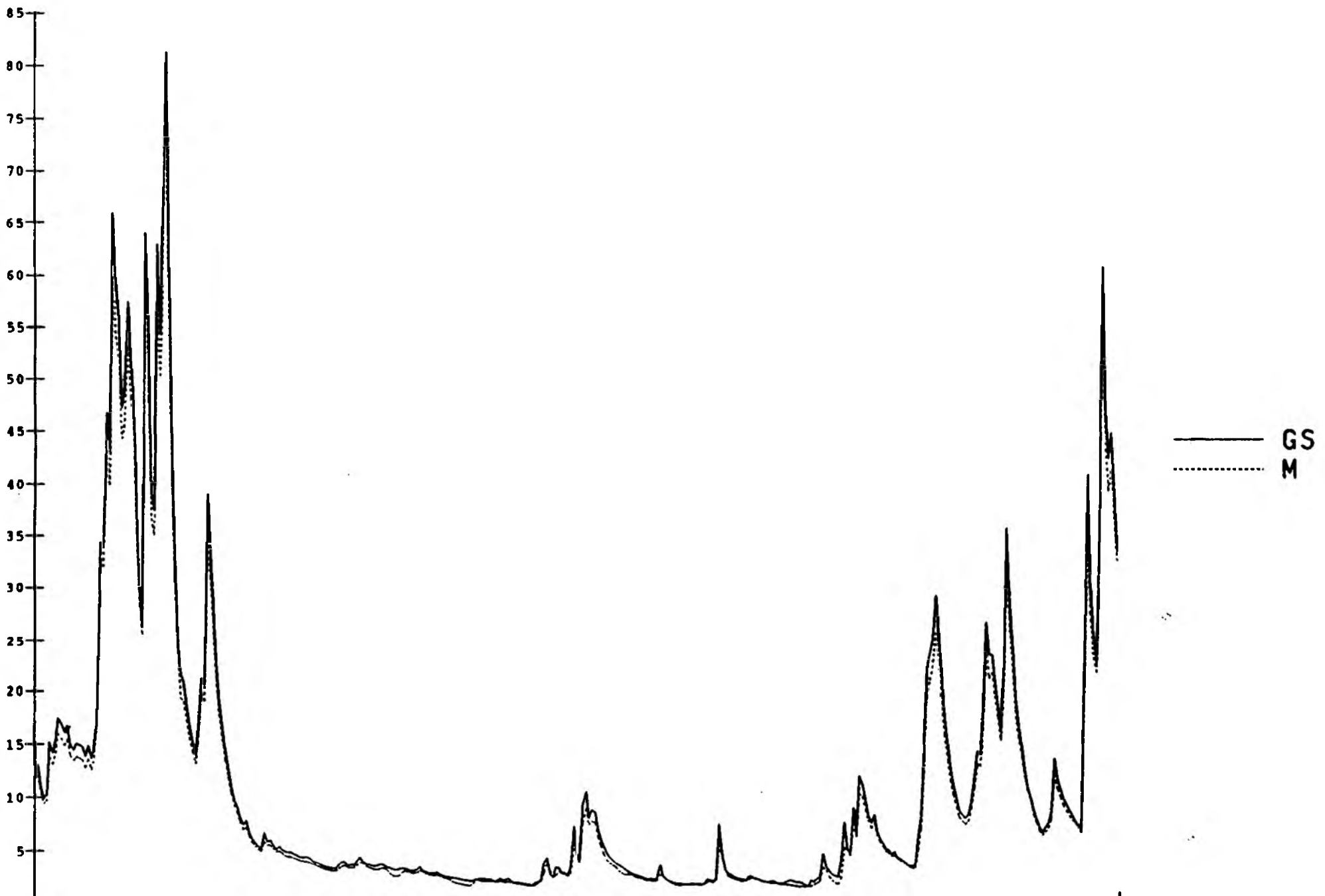
Annual Profiles for:

Stoodleigh	1989
	1990
Thorverton	1989
	1990

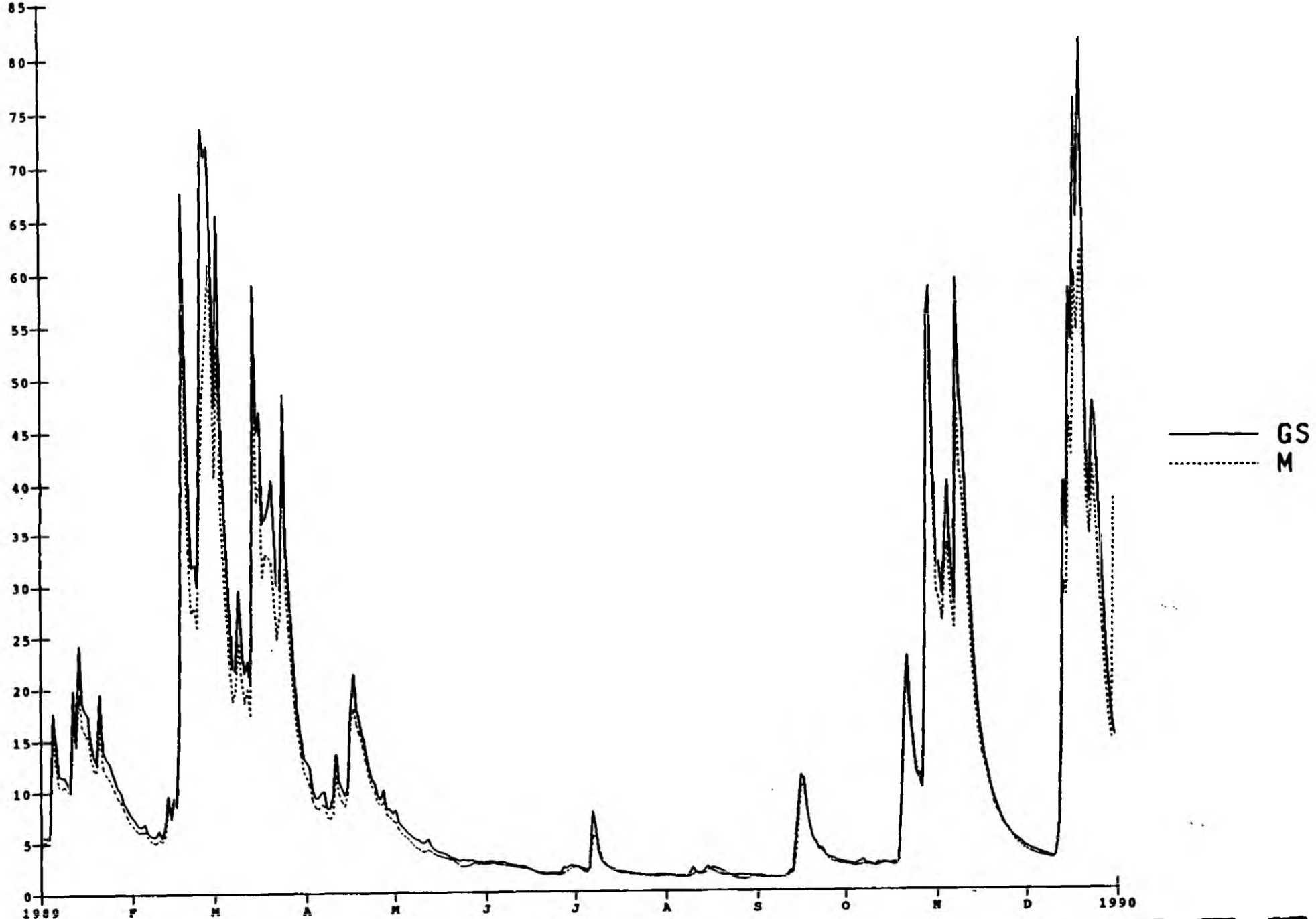
Flow at Stoodleigh 1989



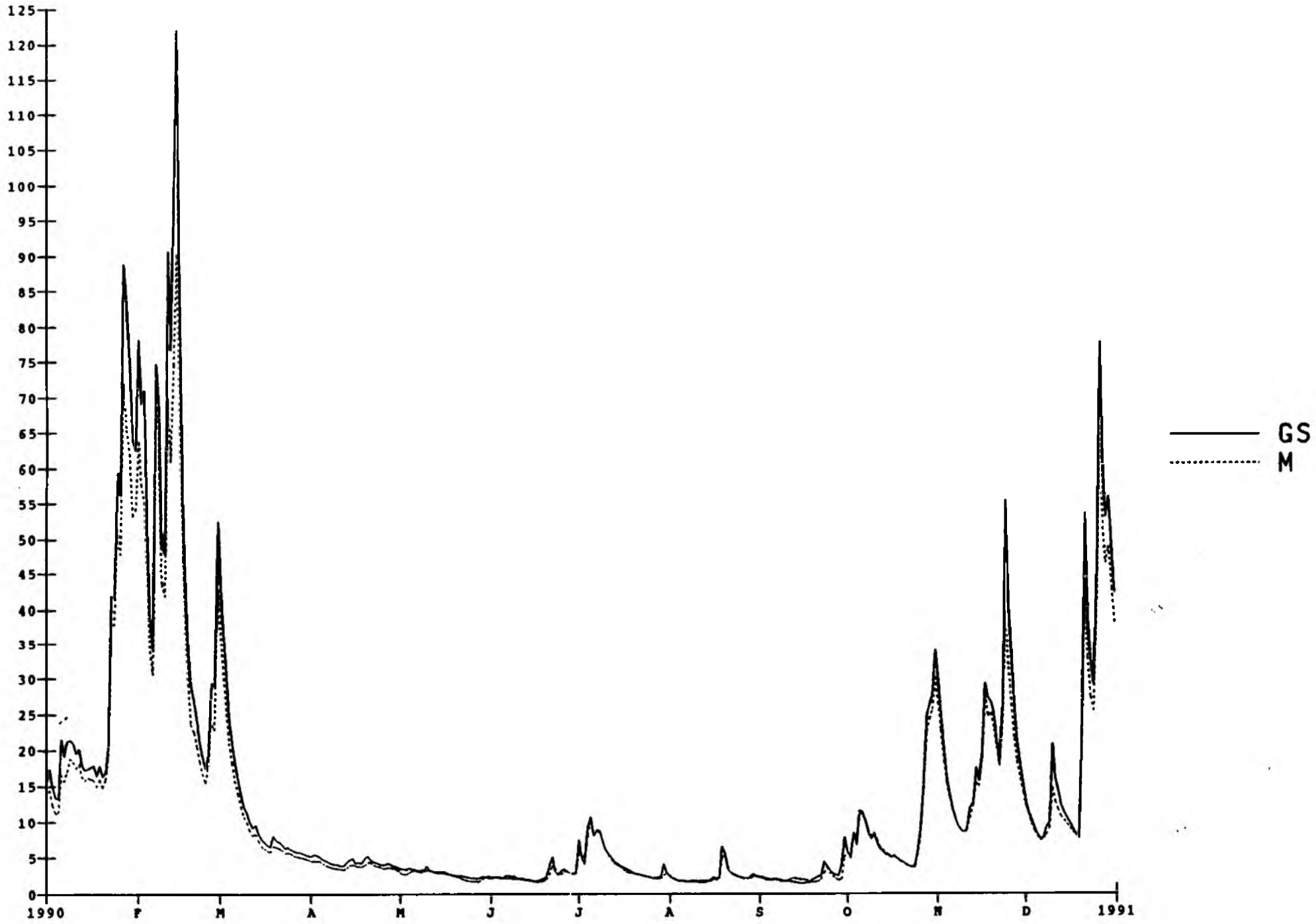
Flow at Stoodleigh 1990



Flow at Thorveton 1989



Flow at Thorveton 1990



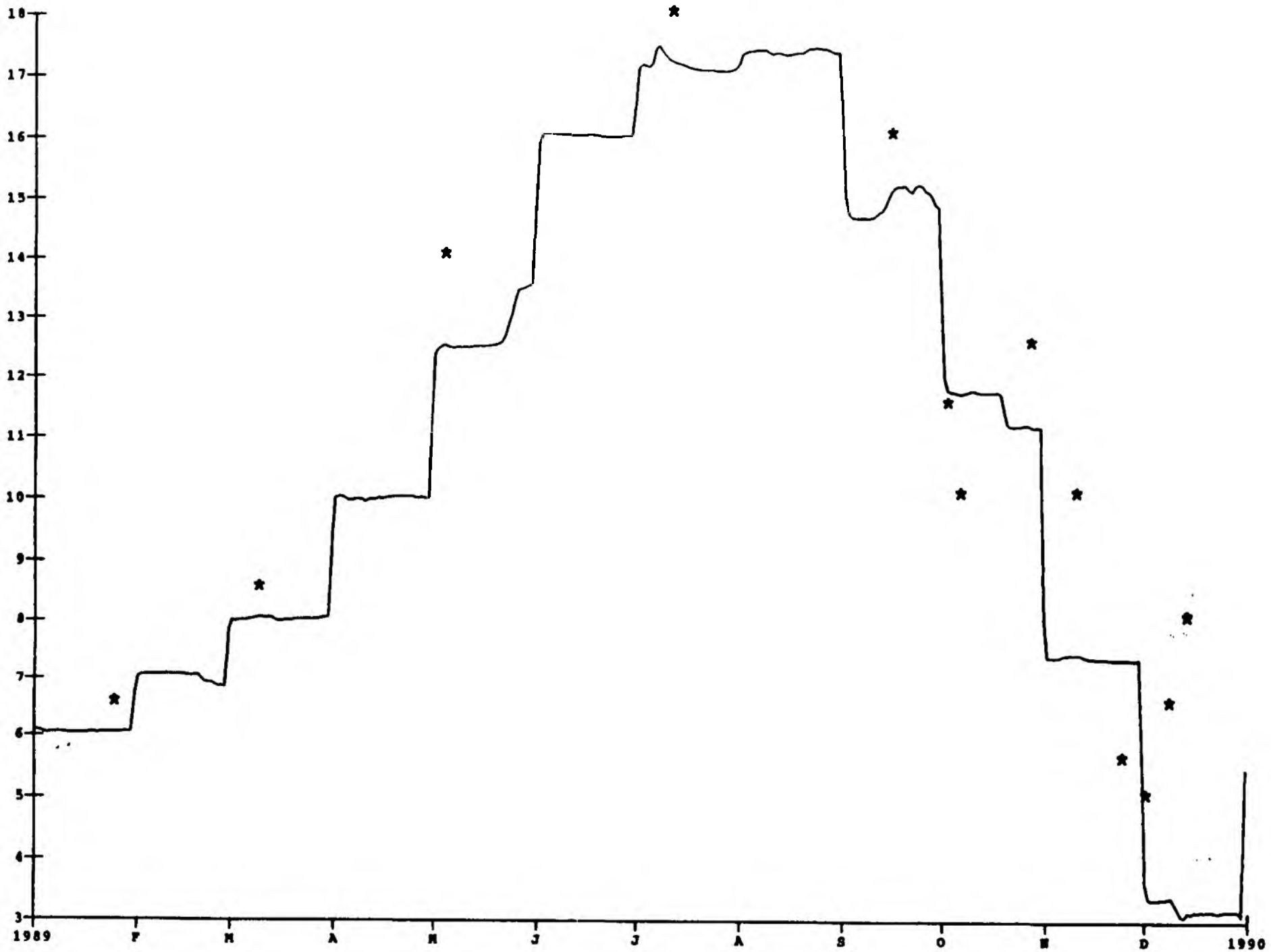
Appendix B - Temperature Profiles

Contents:

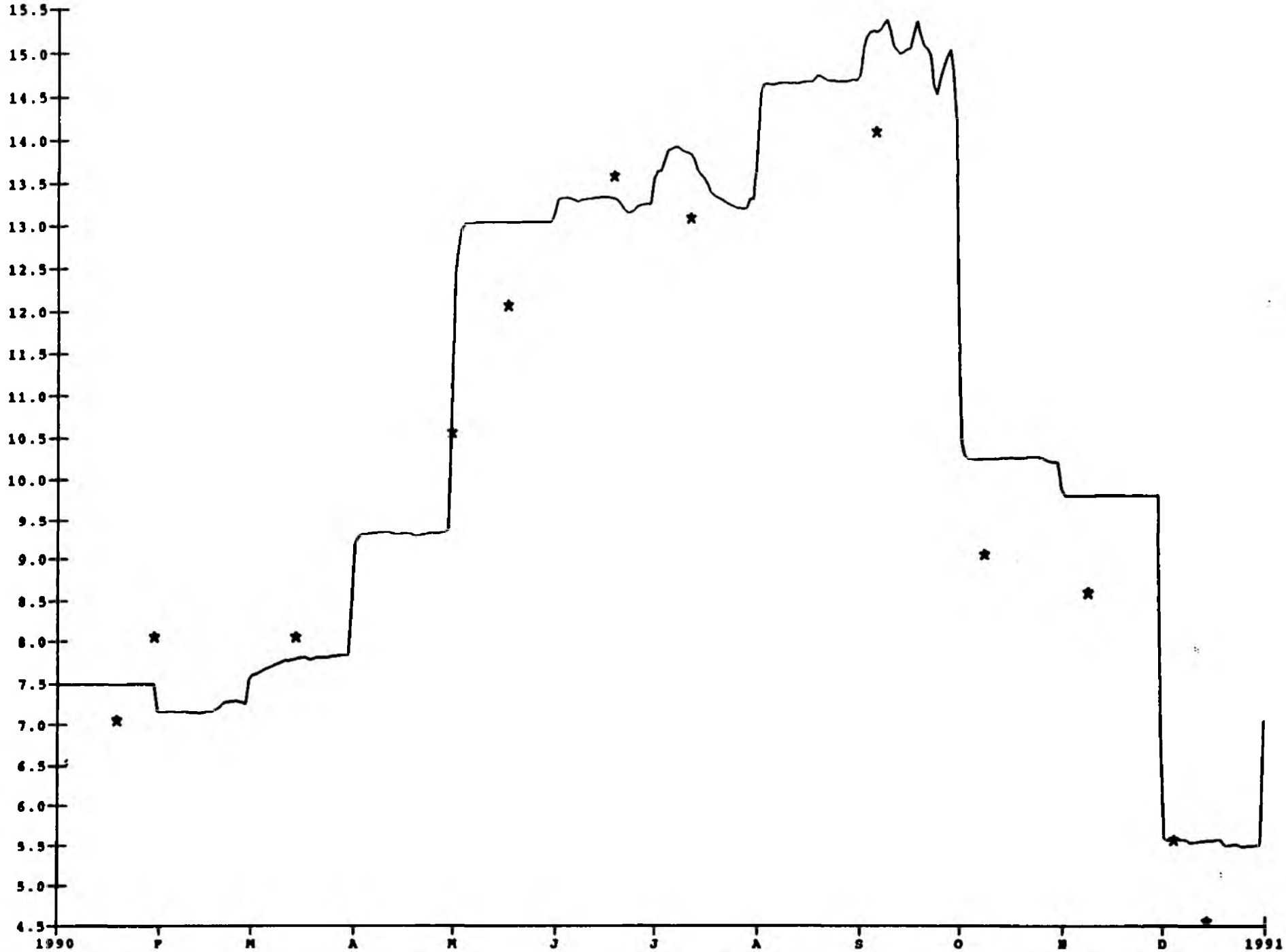
Annual Profiles for:

Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

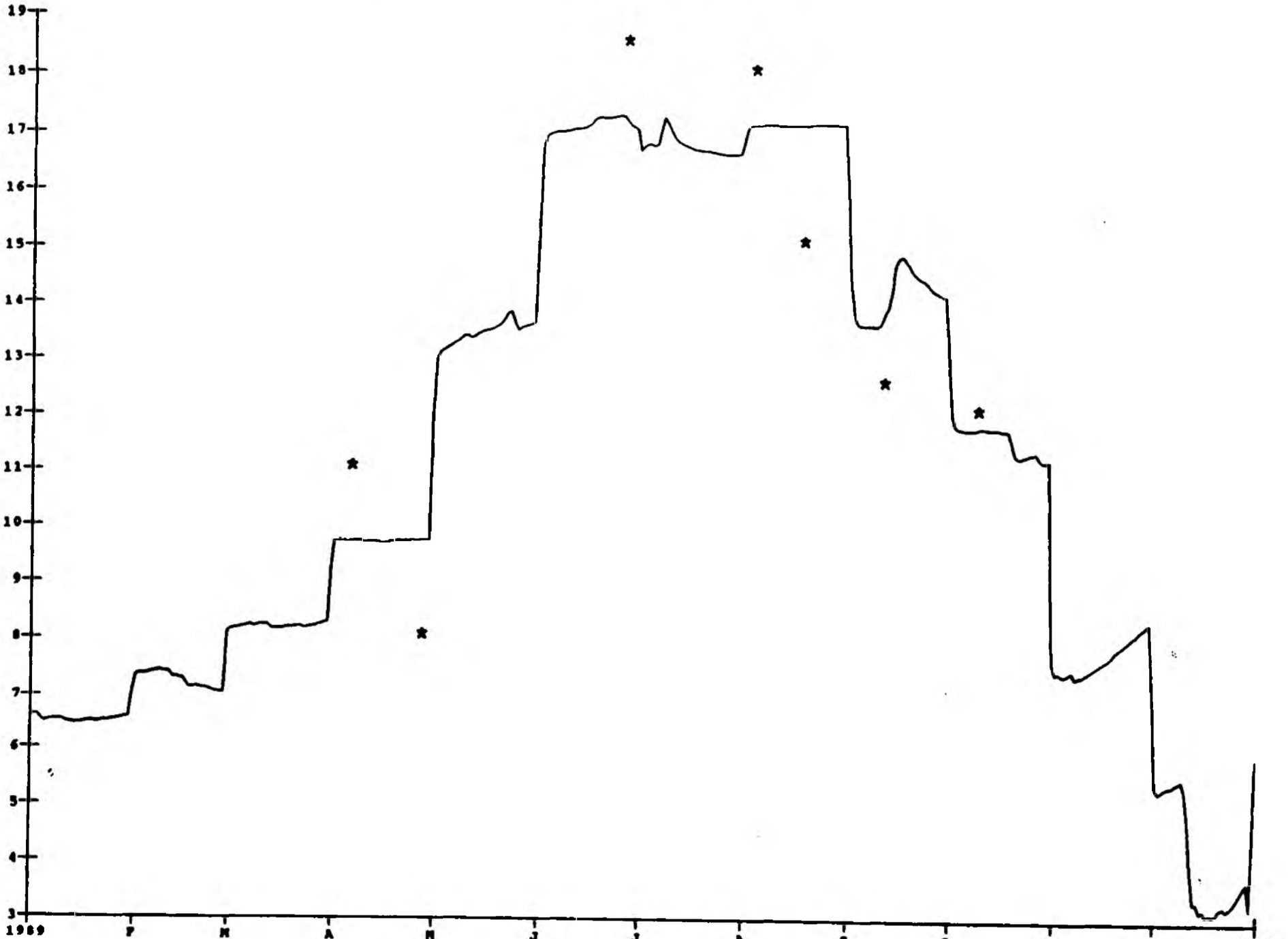
Temperature at Pixton 1989



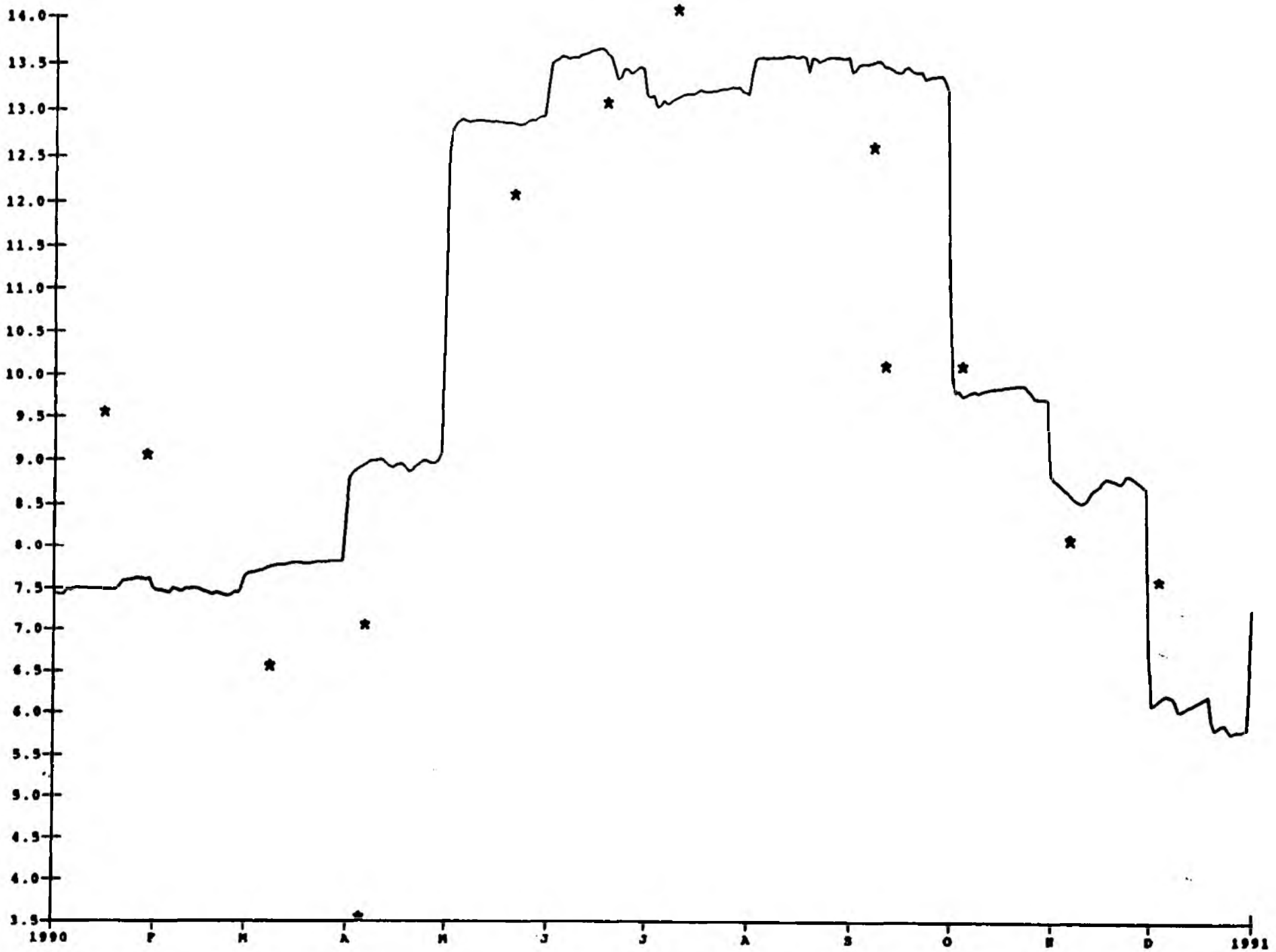
Temperature at Pixton 1990



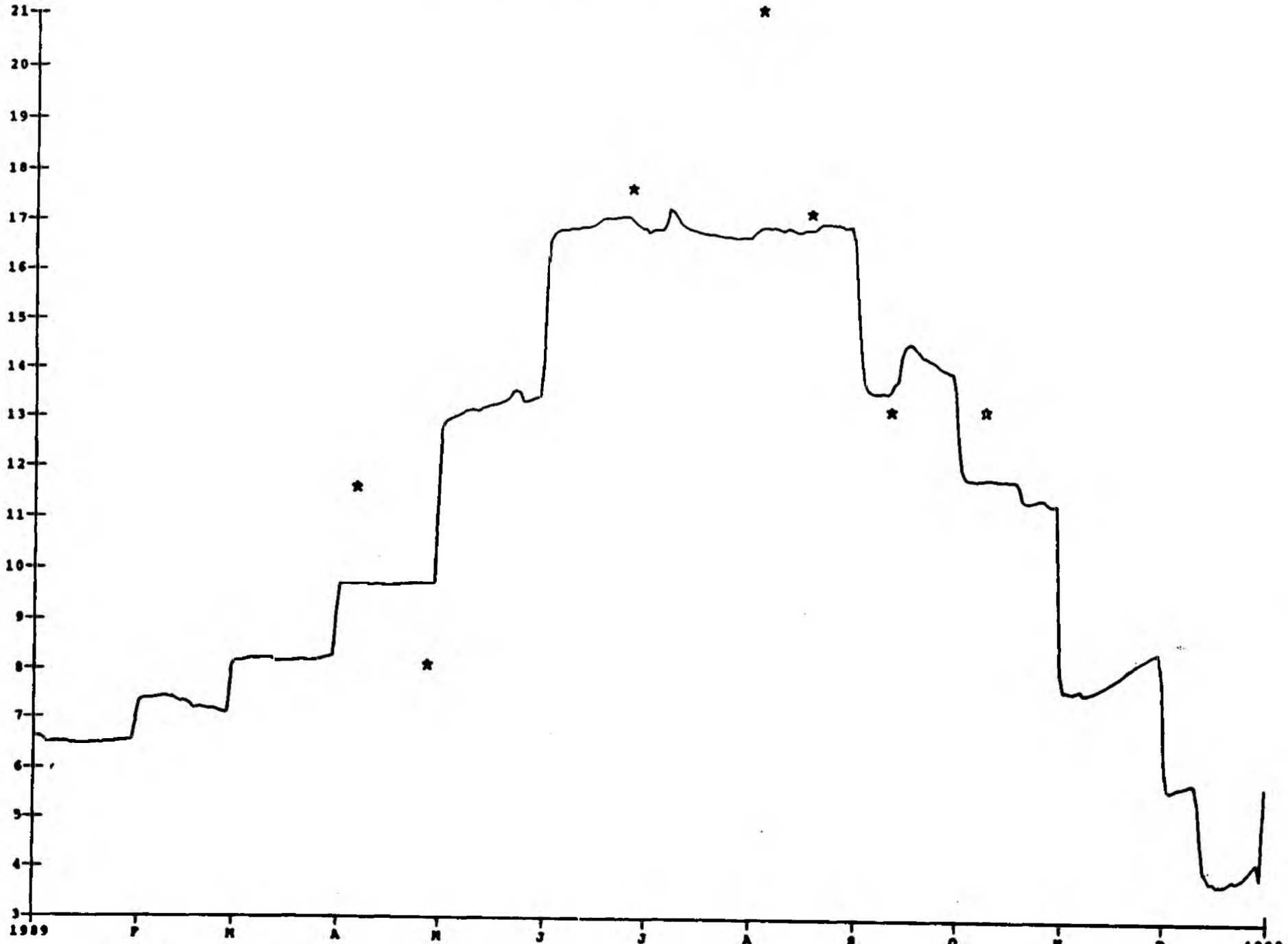
Temperature at Halfpenny 1989



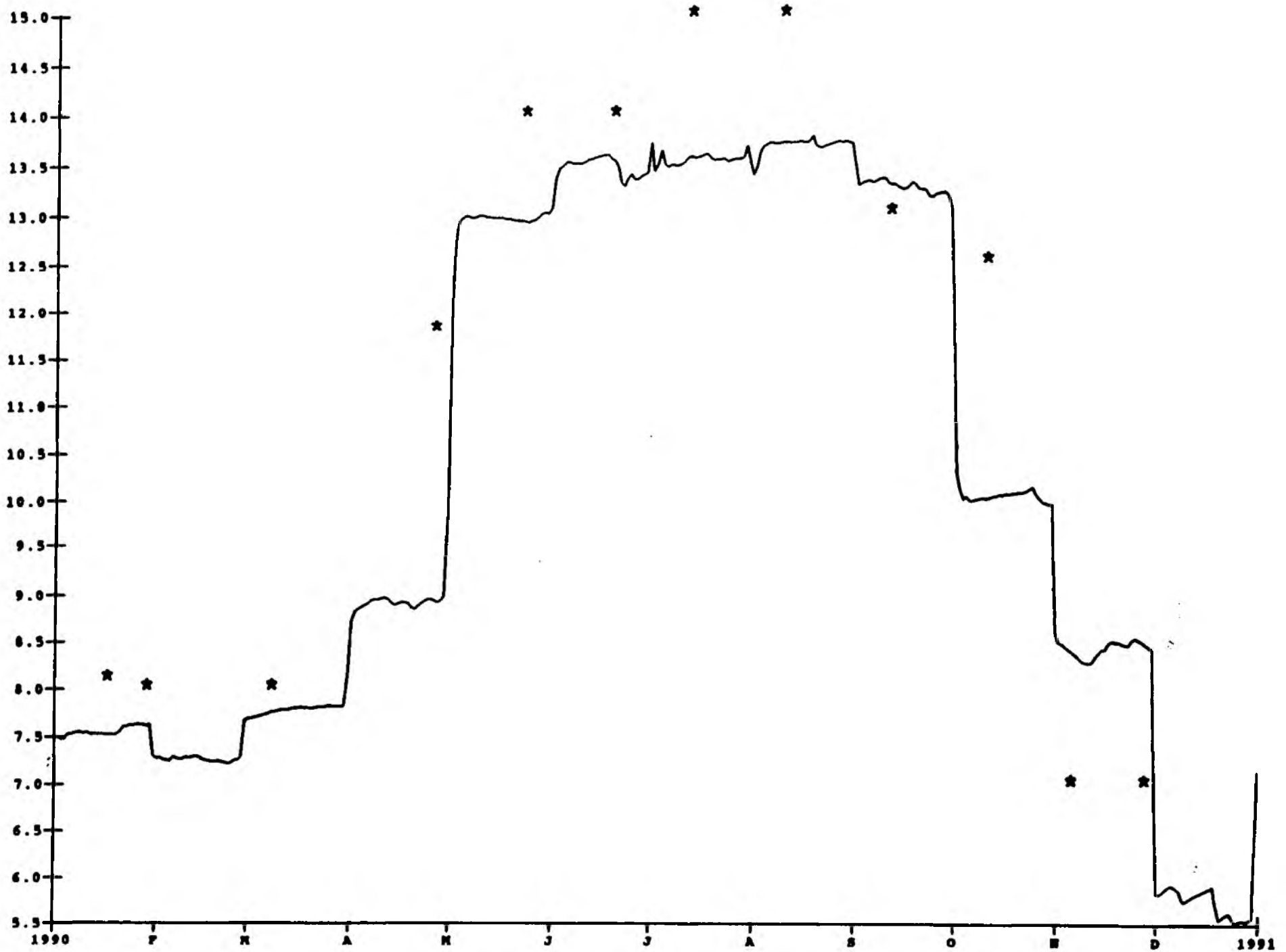
Temperature at Halfpenny 1990



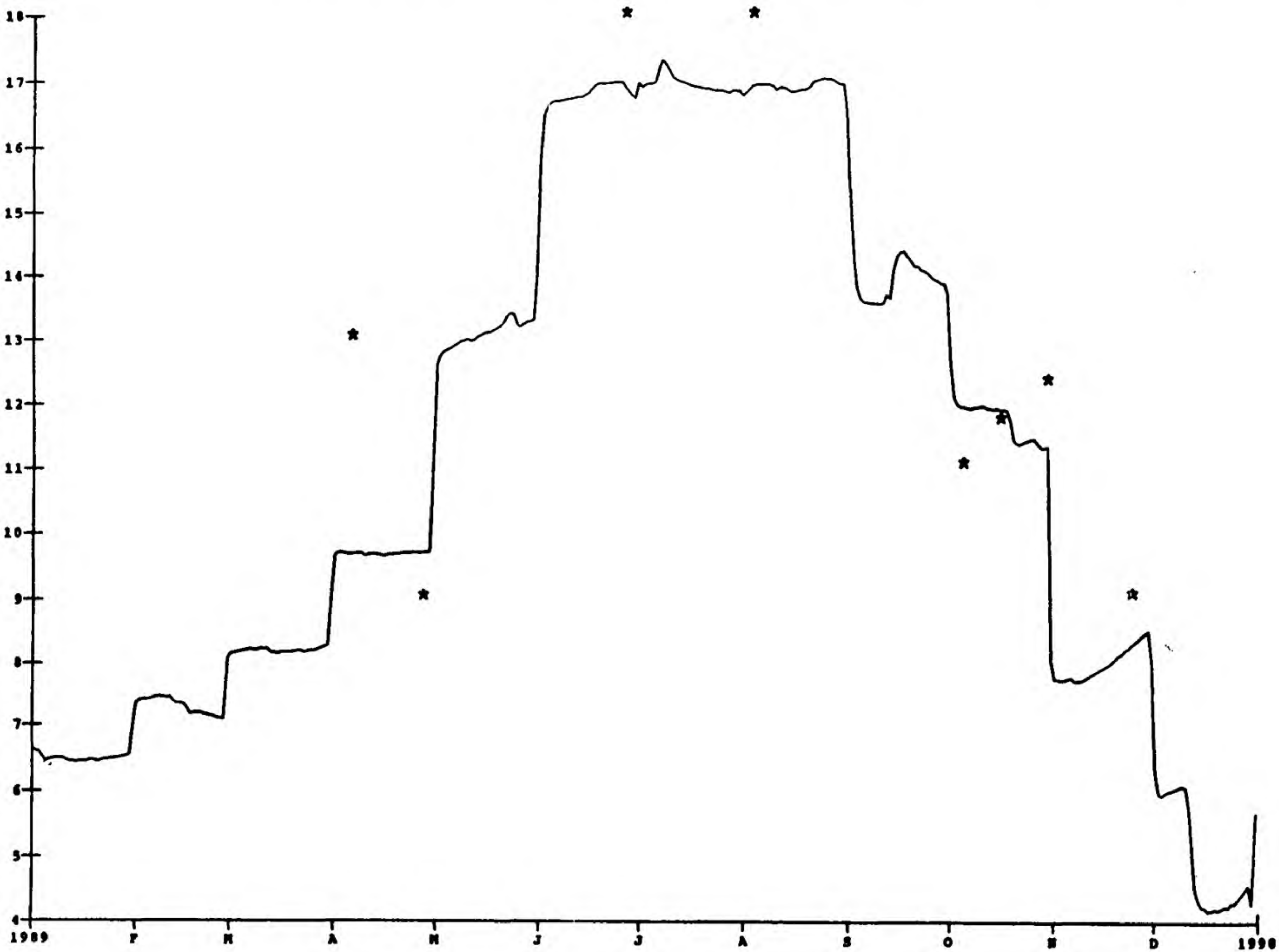
Temperature at Tiverton 1989



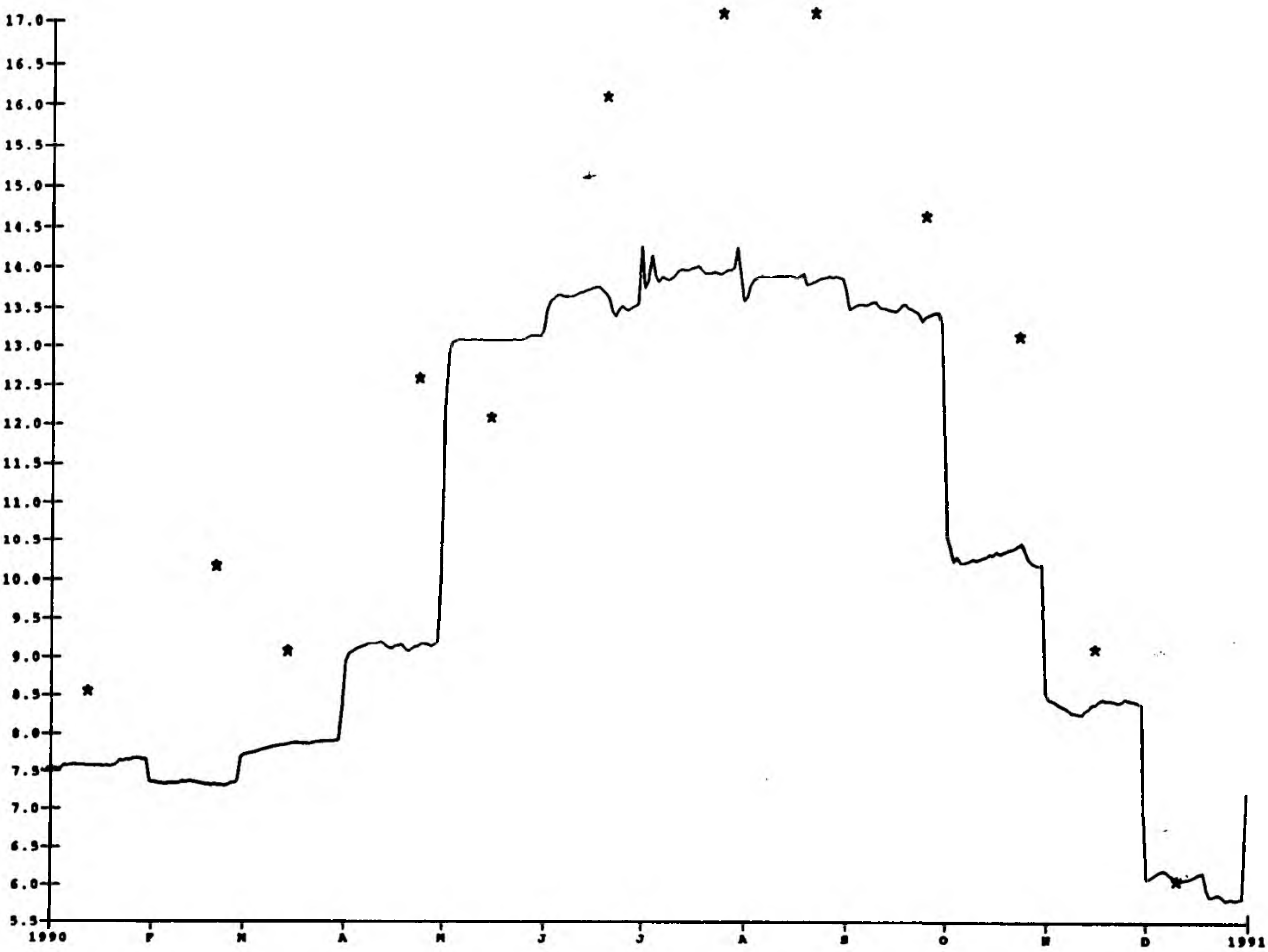
Temperature at Tiverton 1990



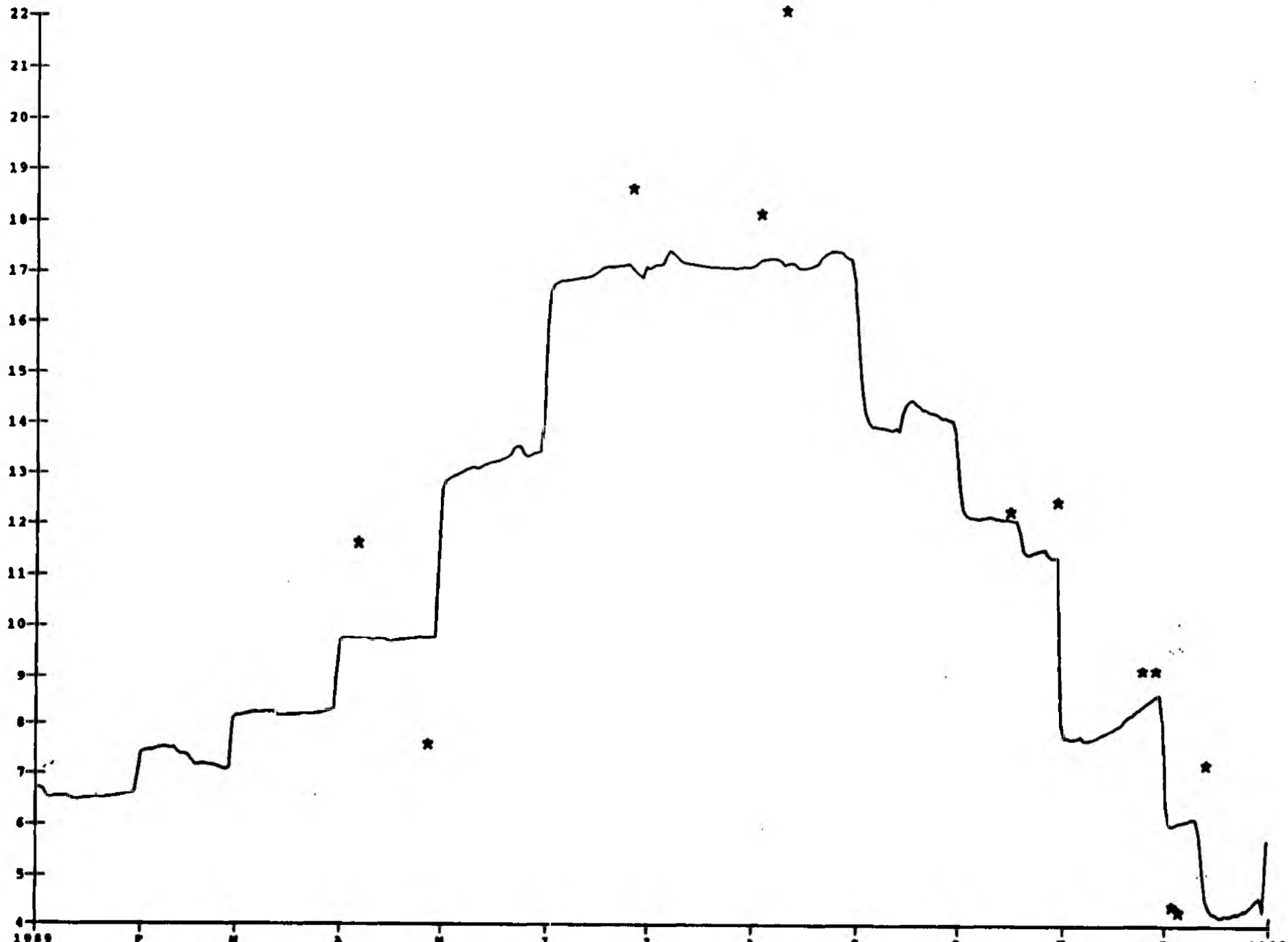
Temperature at Co[illegible] Test 1989



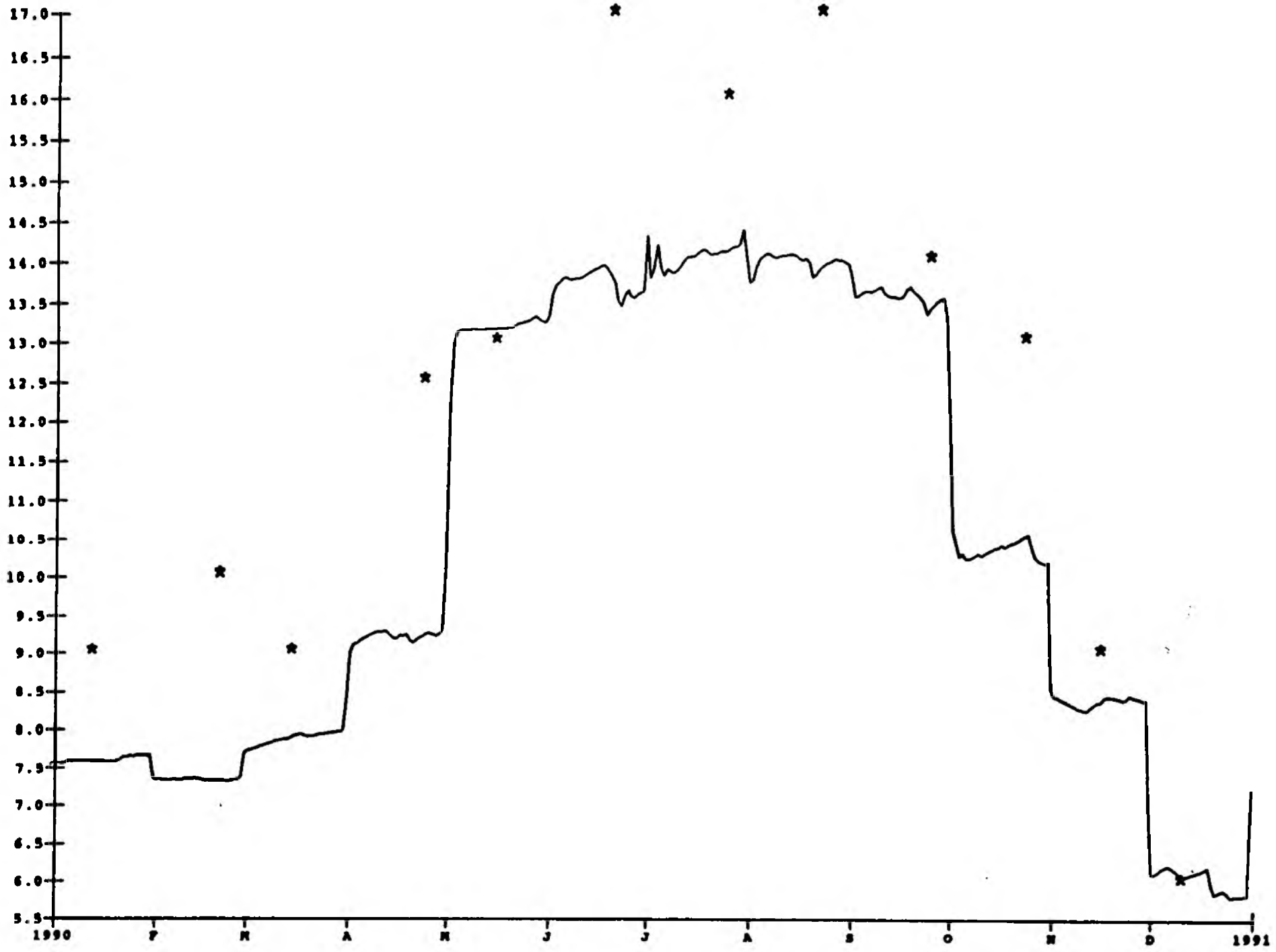
Temperature at Collipriest 1990



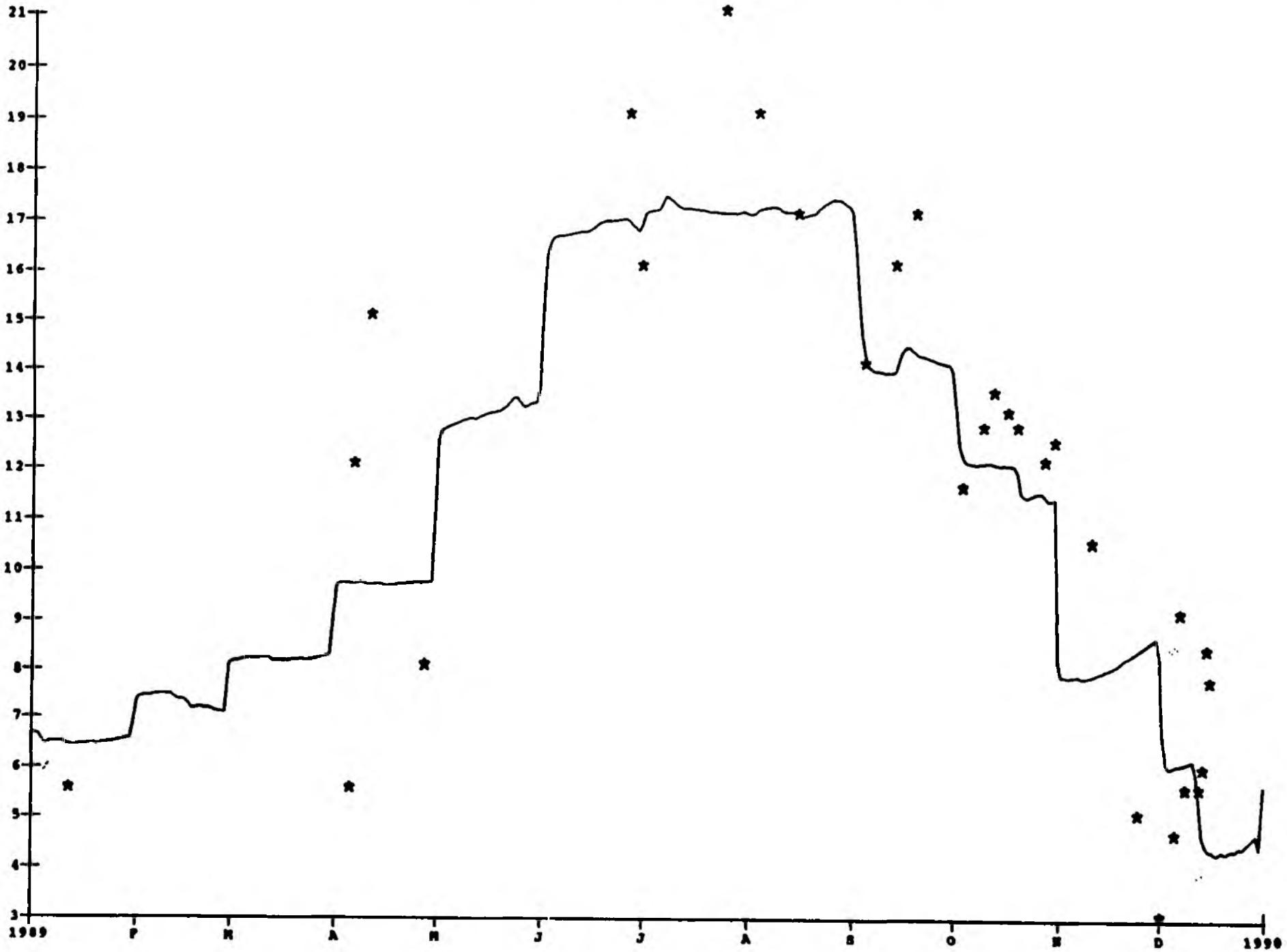
Temperature at Ashley 1989



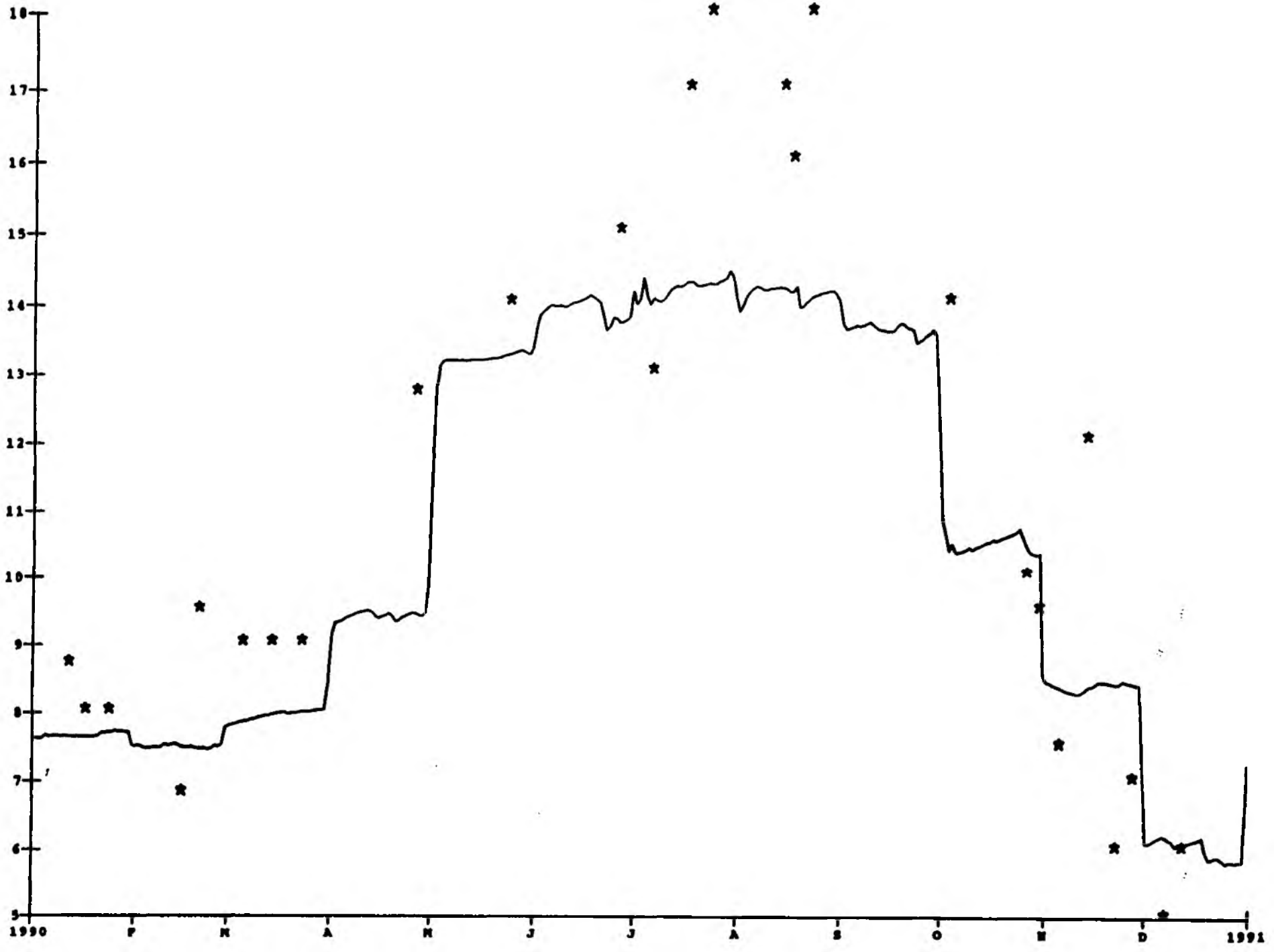
Temperature at Ashley 1990



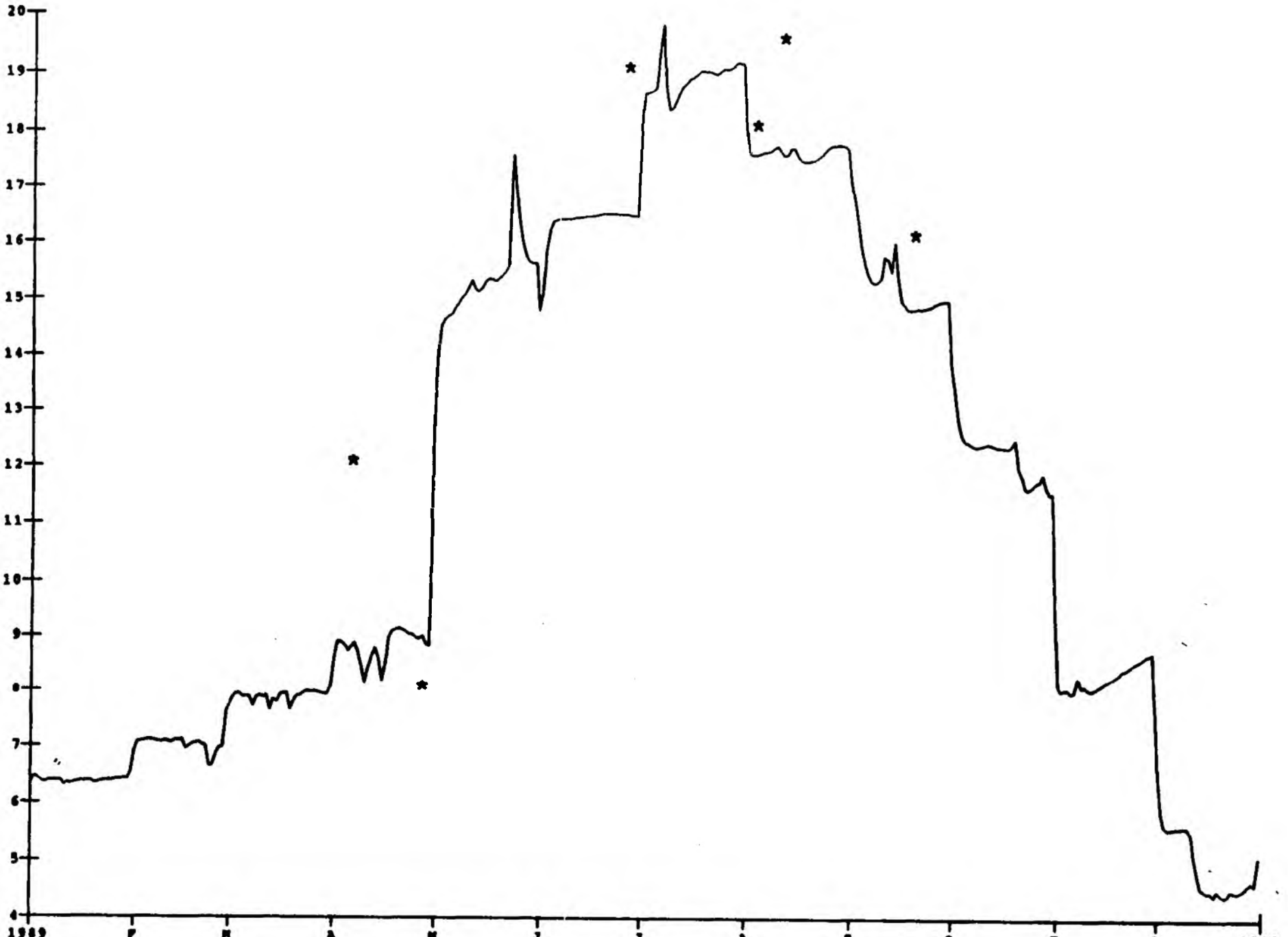
Temperature at Thorveton 1989



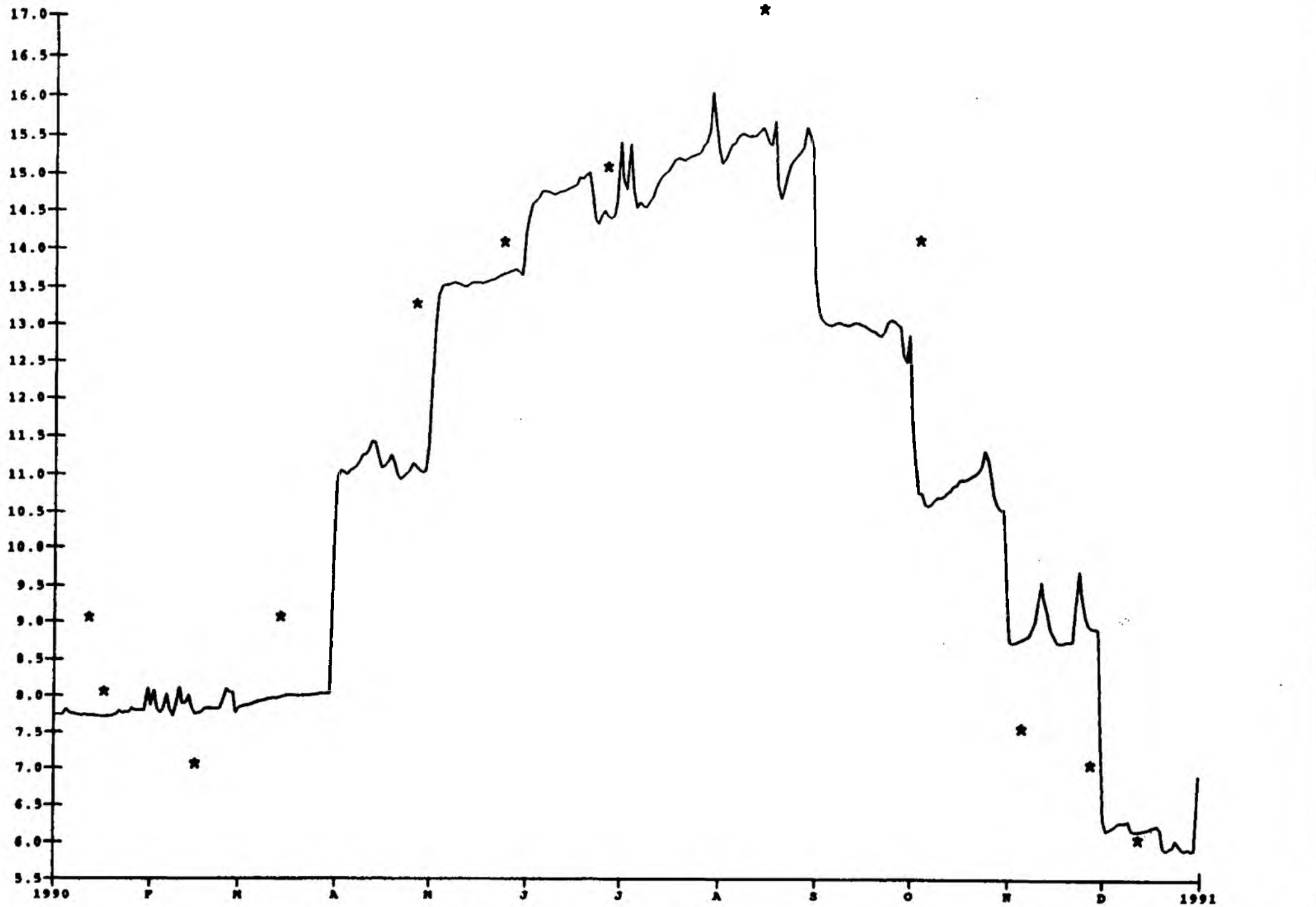
Temperature at Thorverton 1990



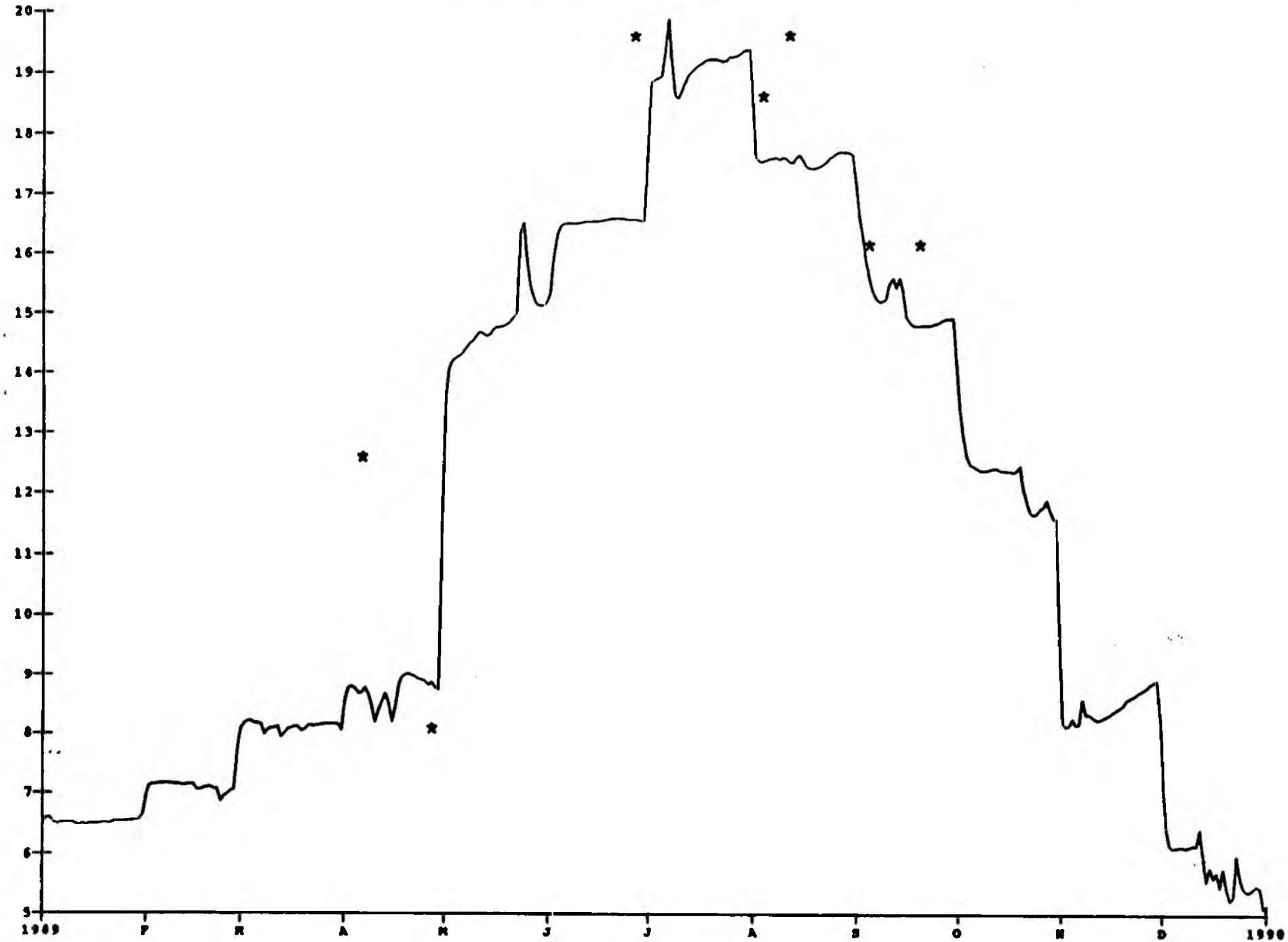
Temperature at Stafford Br. 1989



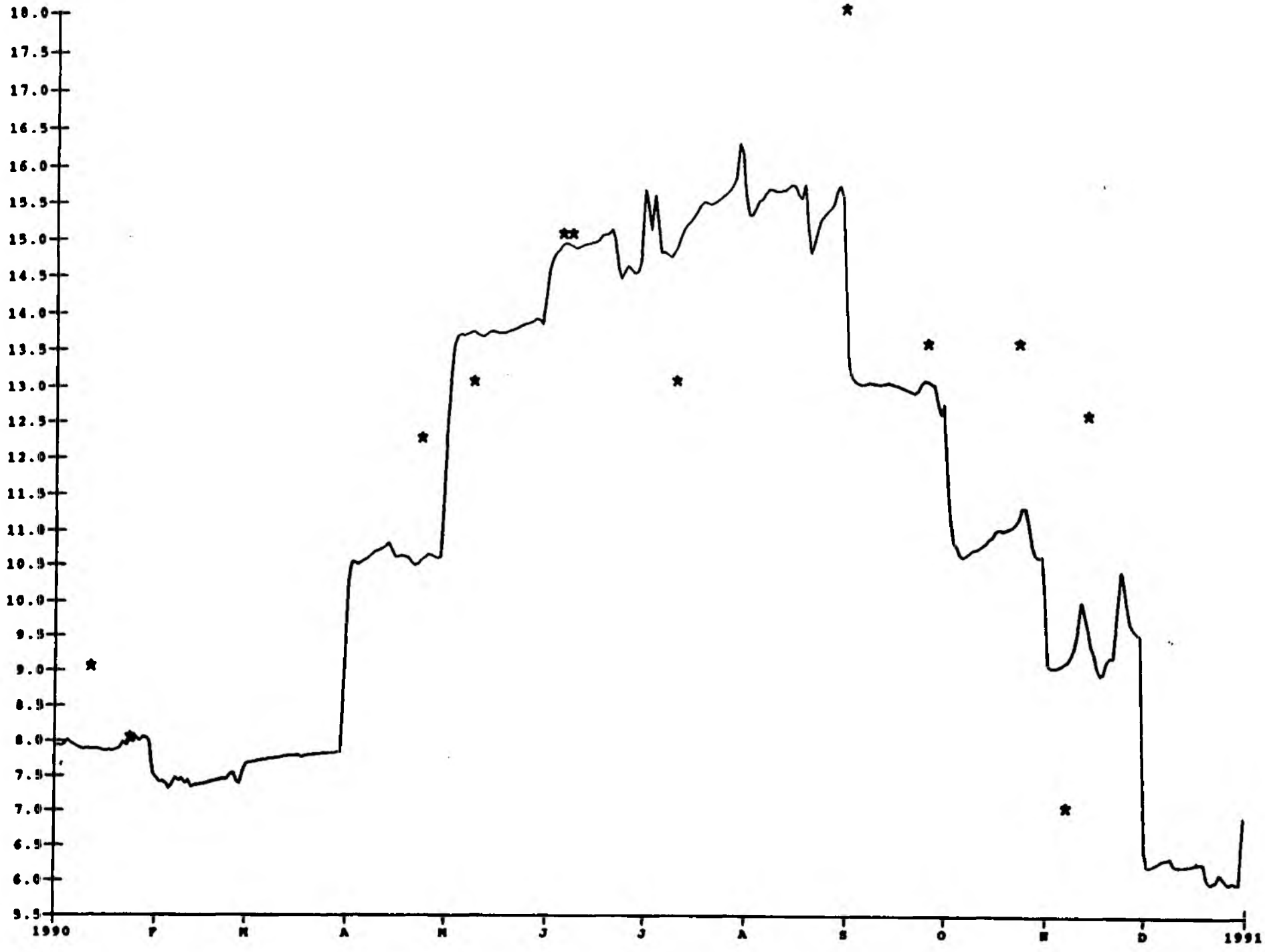
Temperature at Stafford Br. 1990



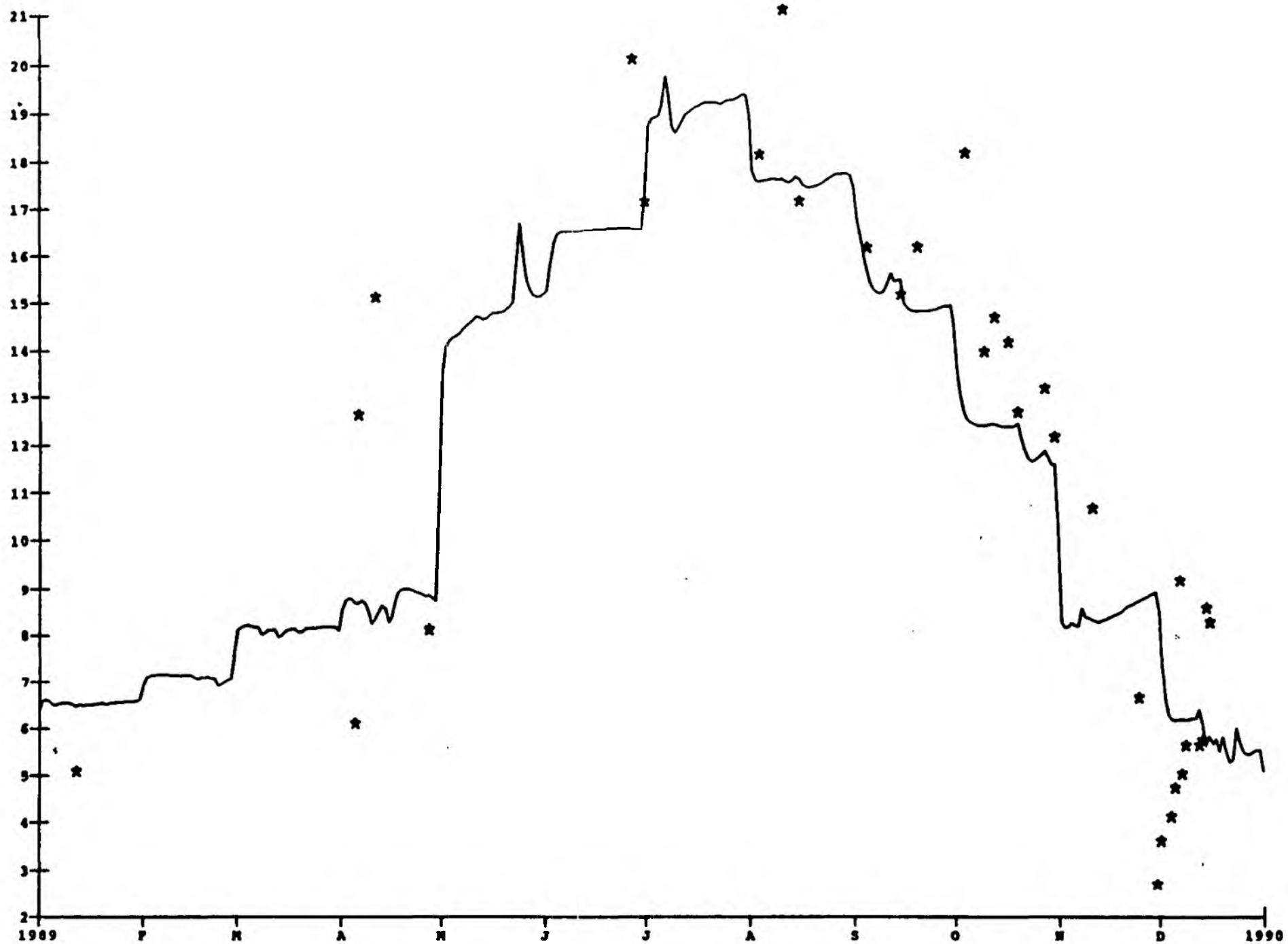
Temperature at Exwick 1989



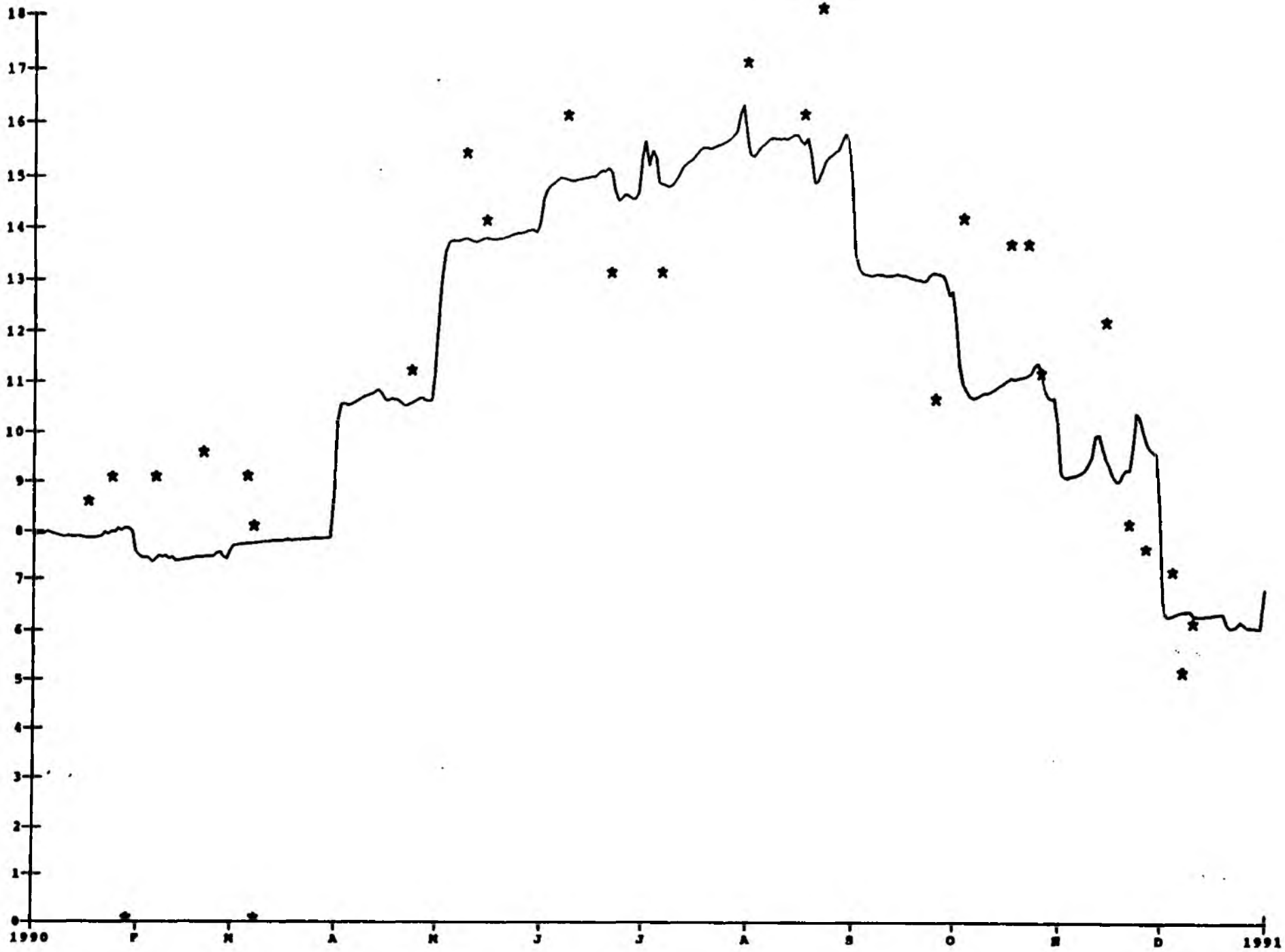
Temperature at Exwick 1990



Temperature at Trews Weir 1989



Temperature at Trews Weir 1990



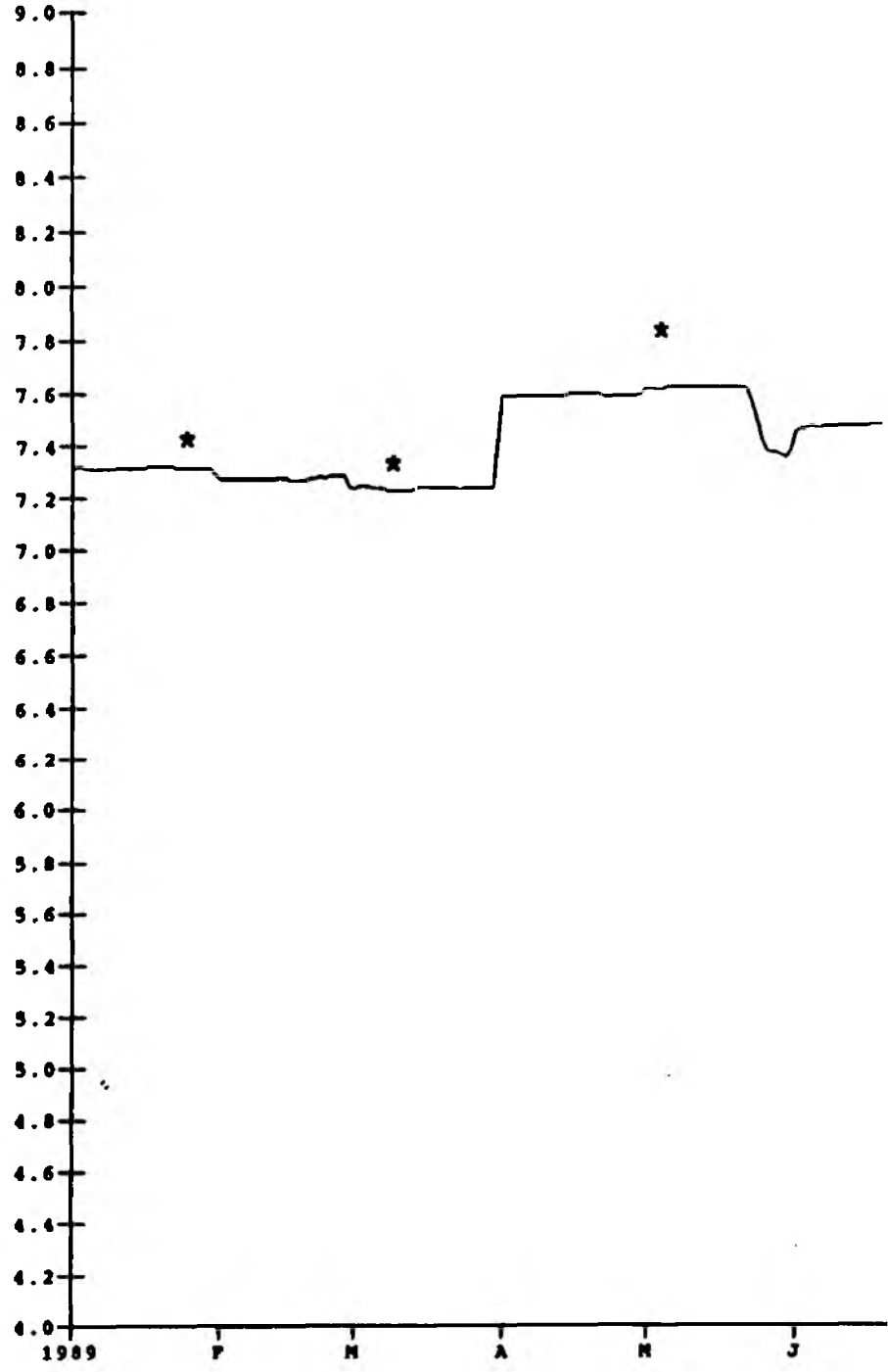
Appendix C - pH Profiles

Contents:

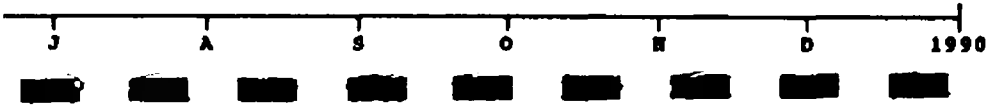
Annual Profiles for:

Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

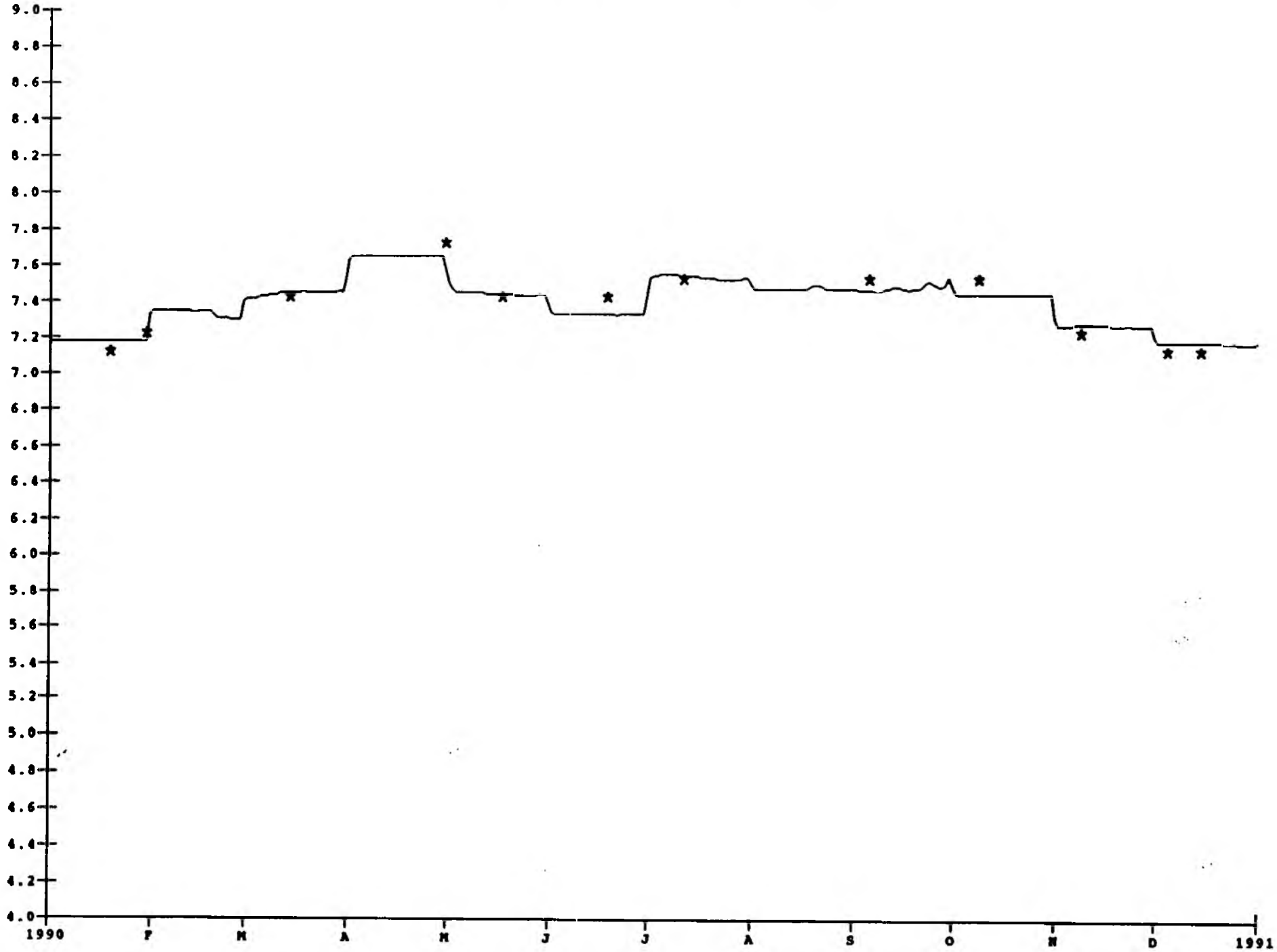
pH at


9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
1989
F
M
A
M
J

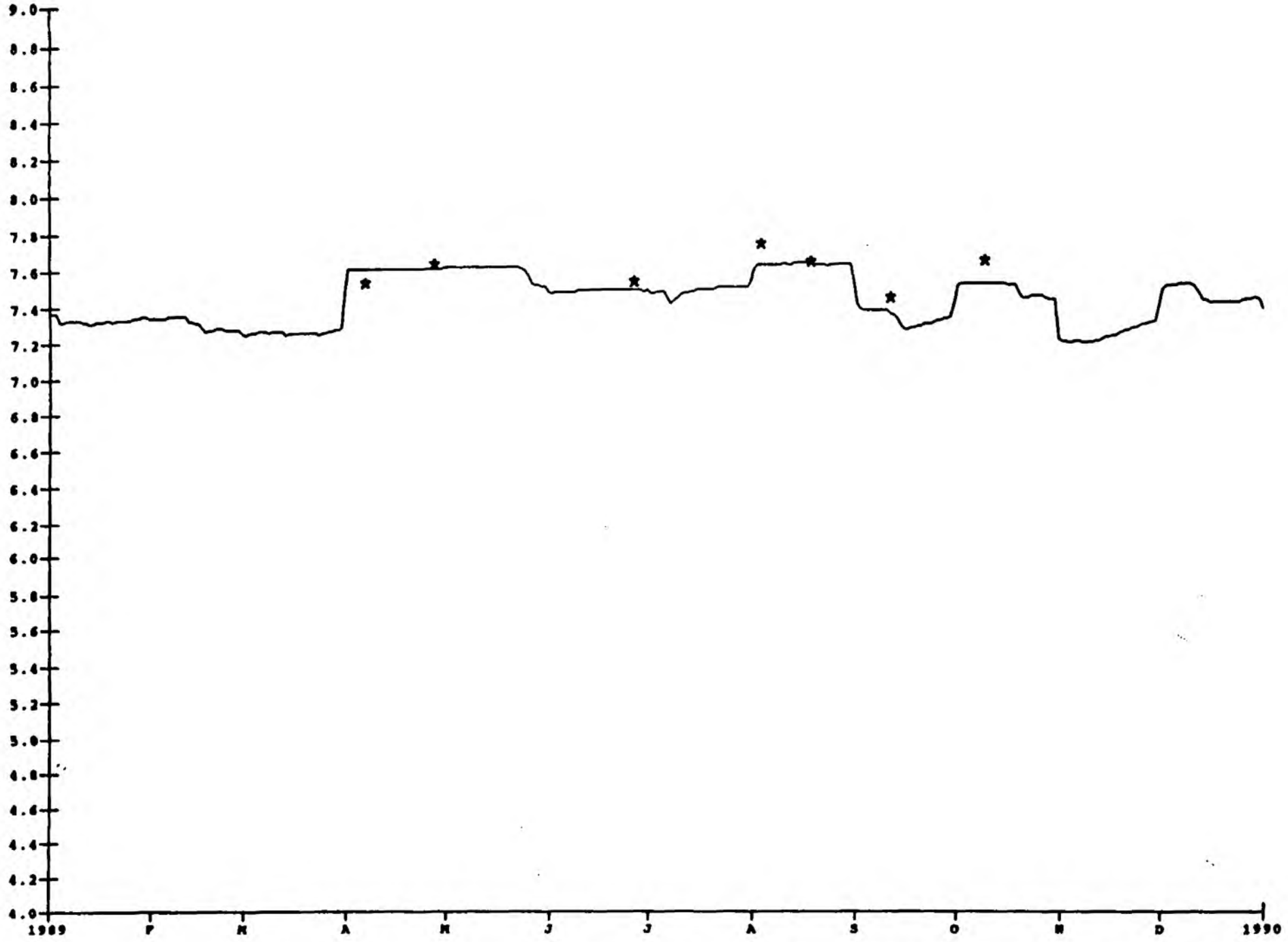
Pixton 1989



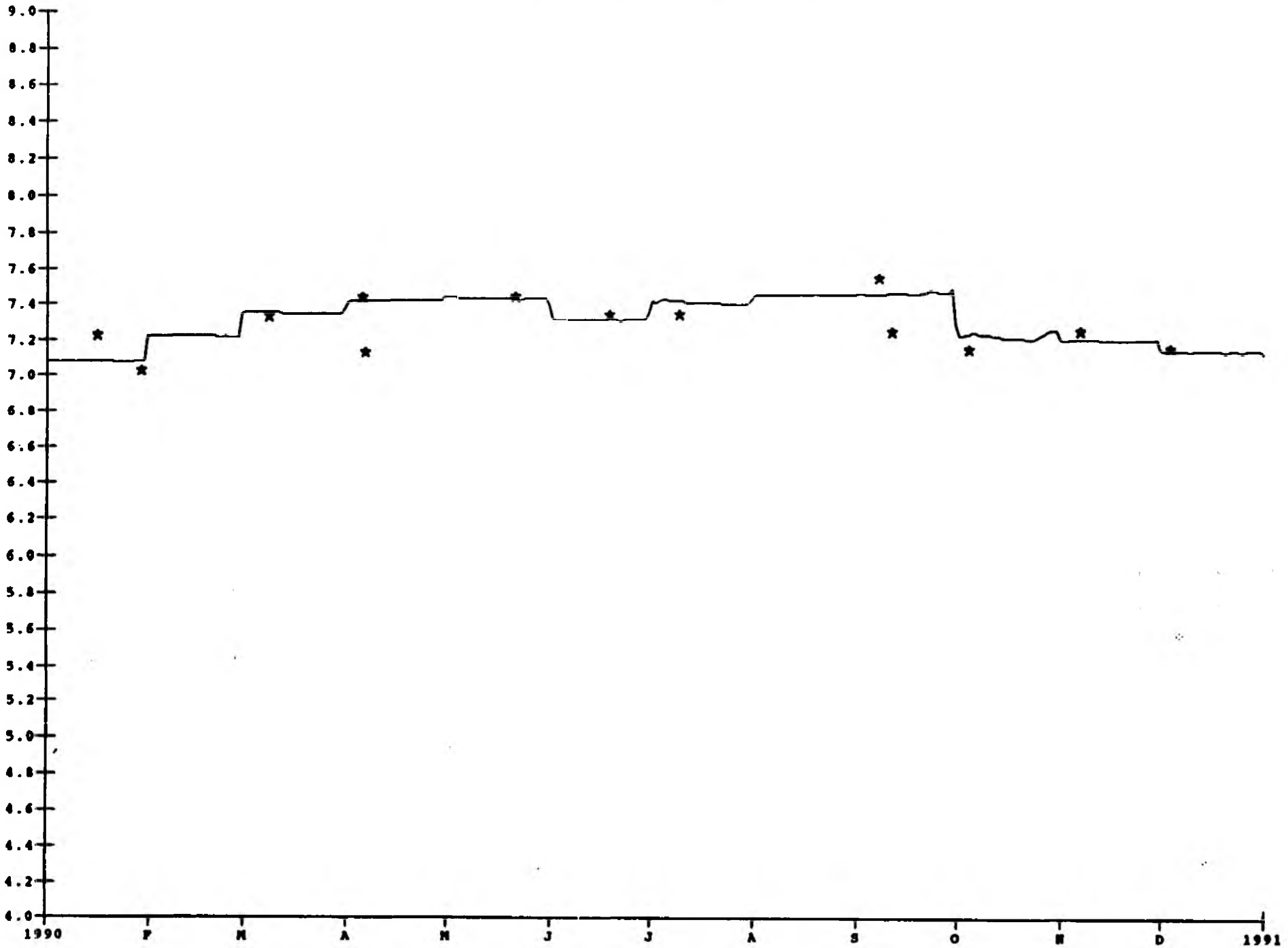
pH at Pixton 1990



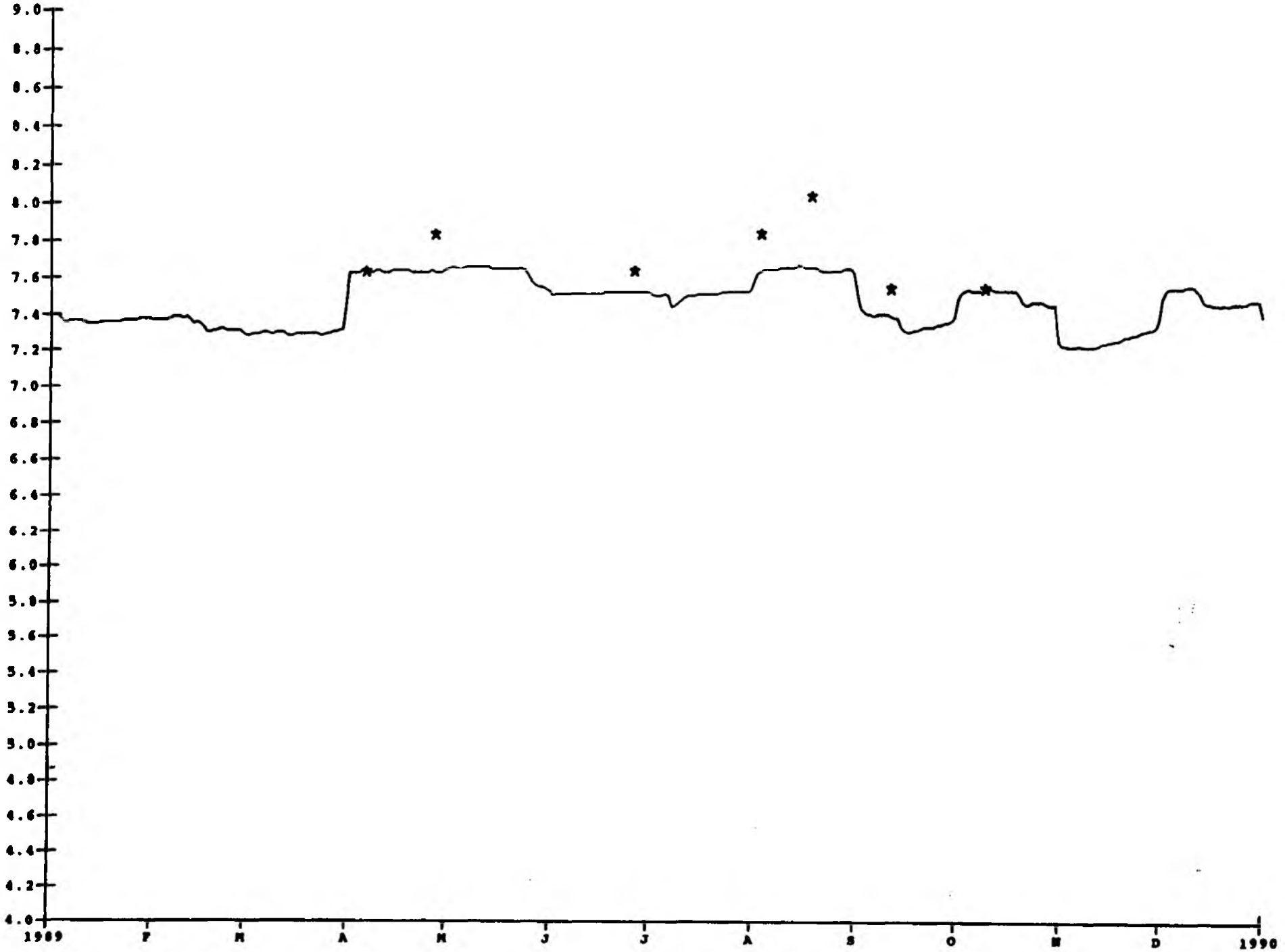
pH at Halfpenny 1989



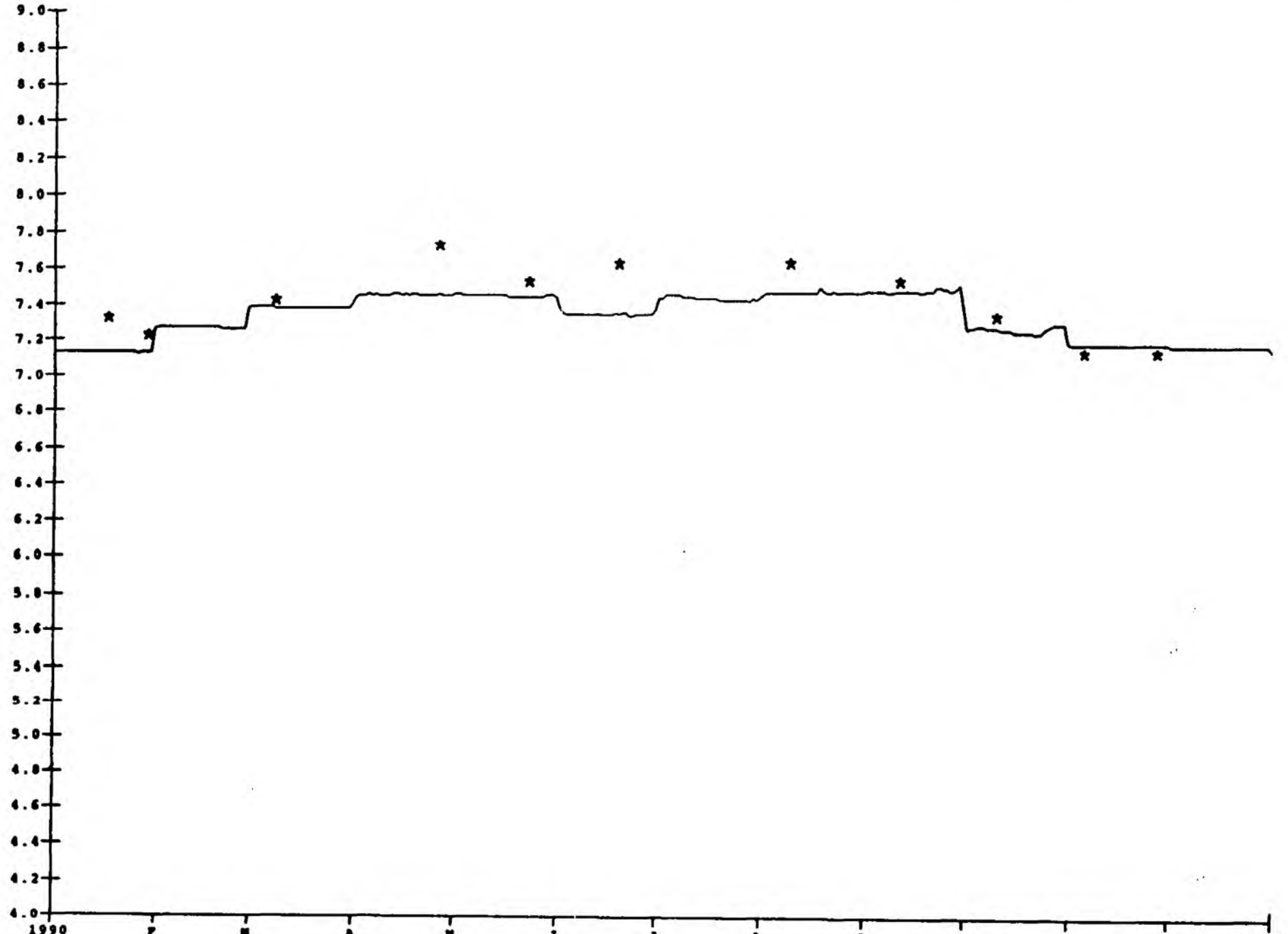
pH at Halfpenny 1990



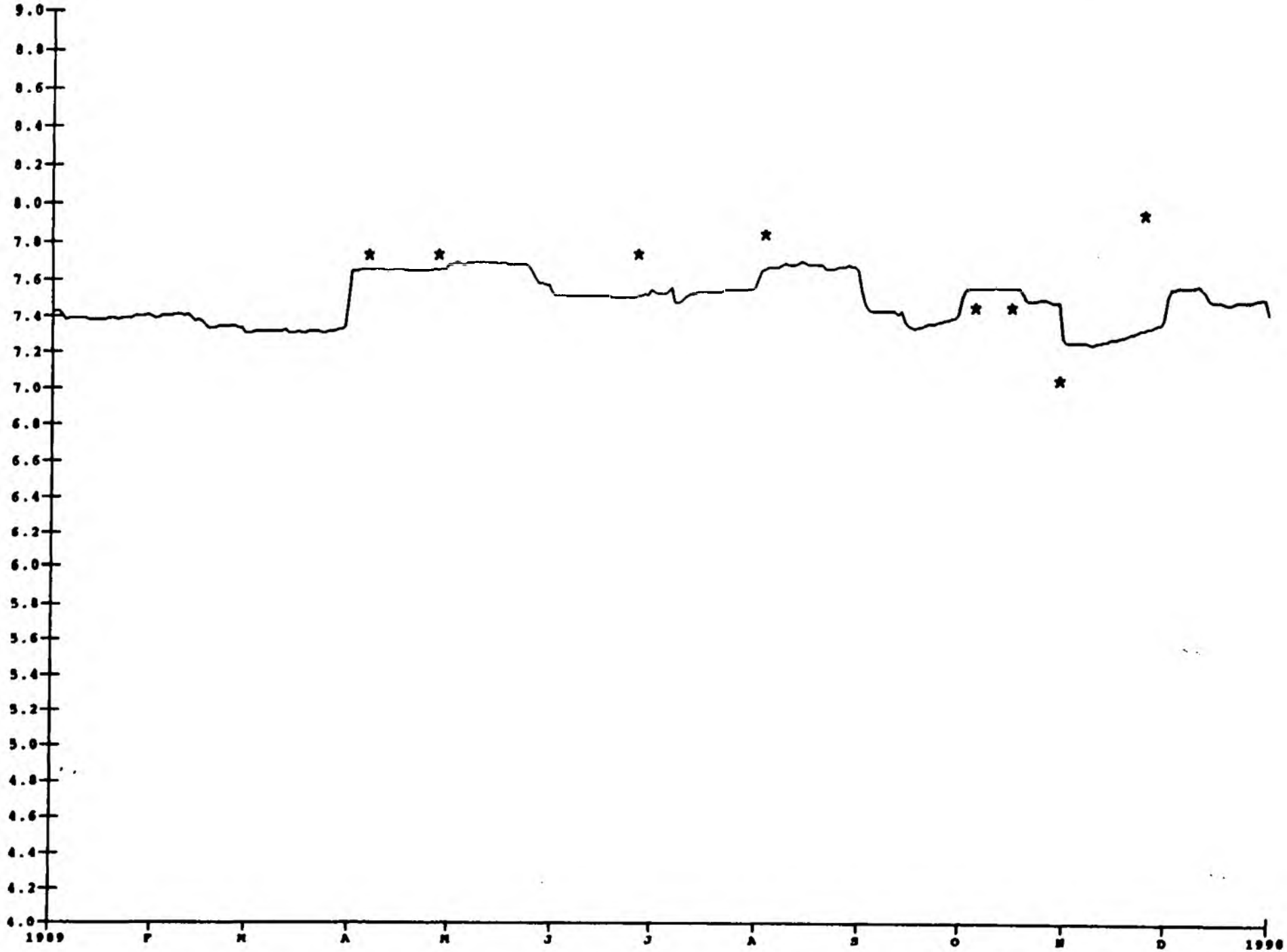
pH at Tiverton 1989



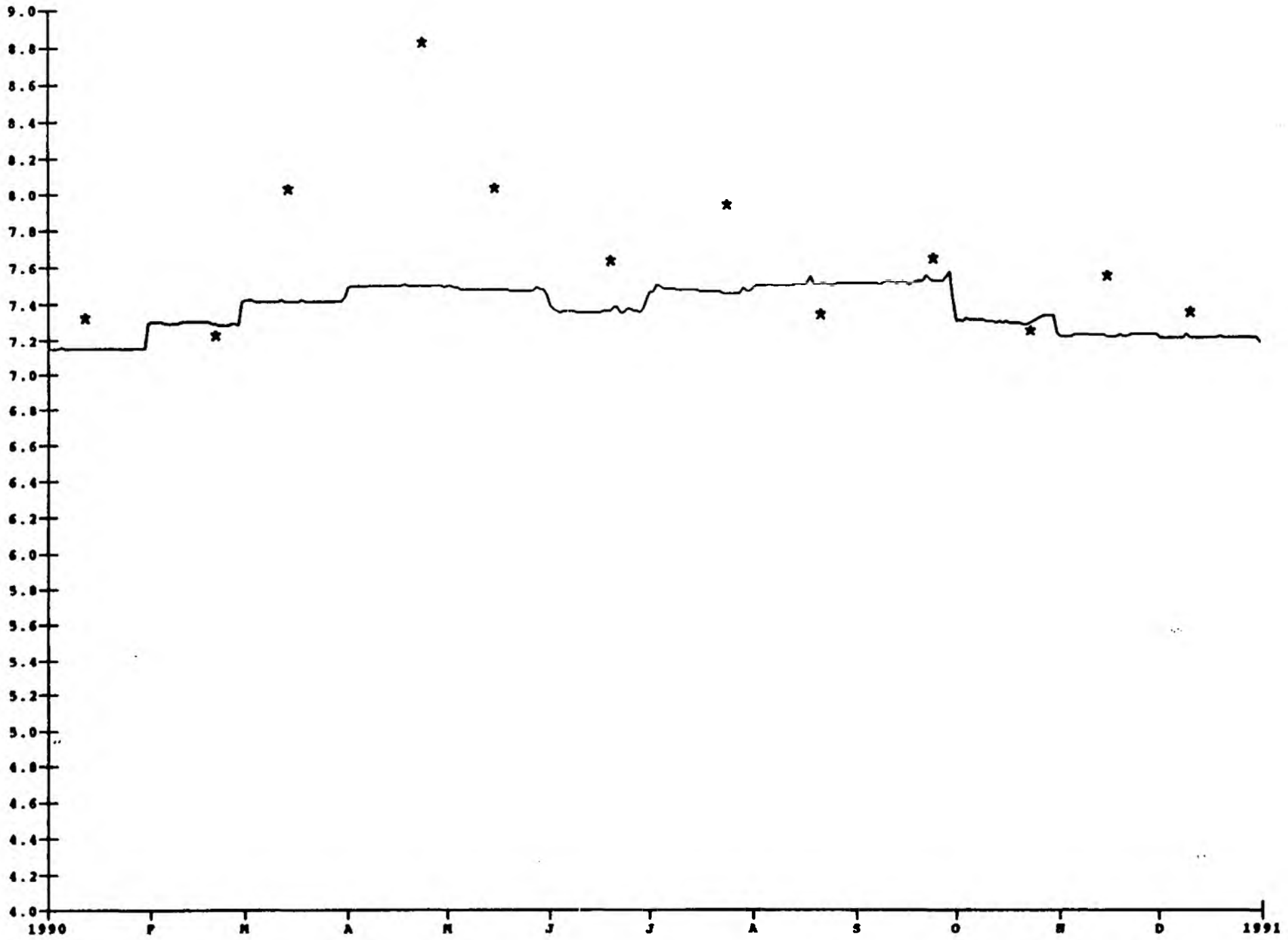
pH at Riverton 1990



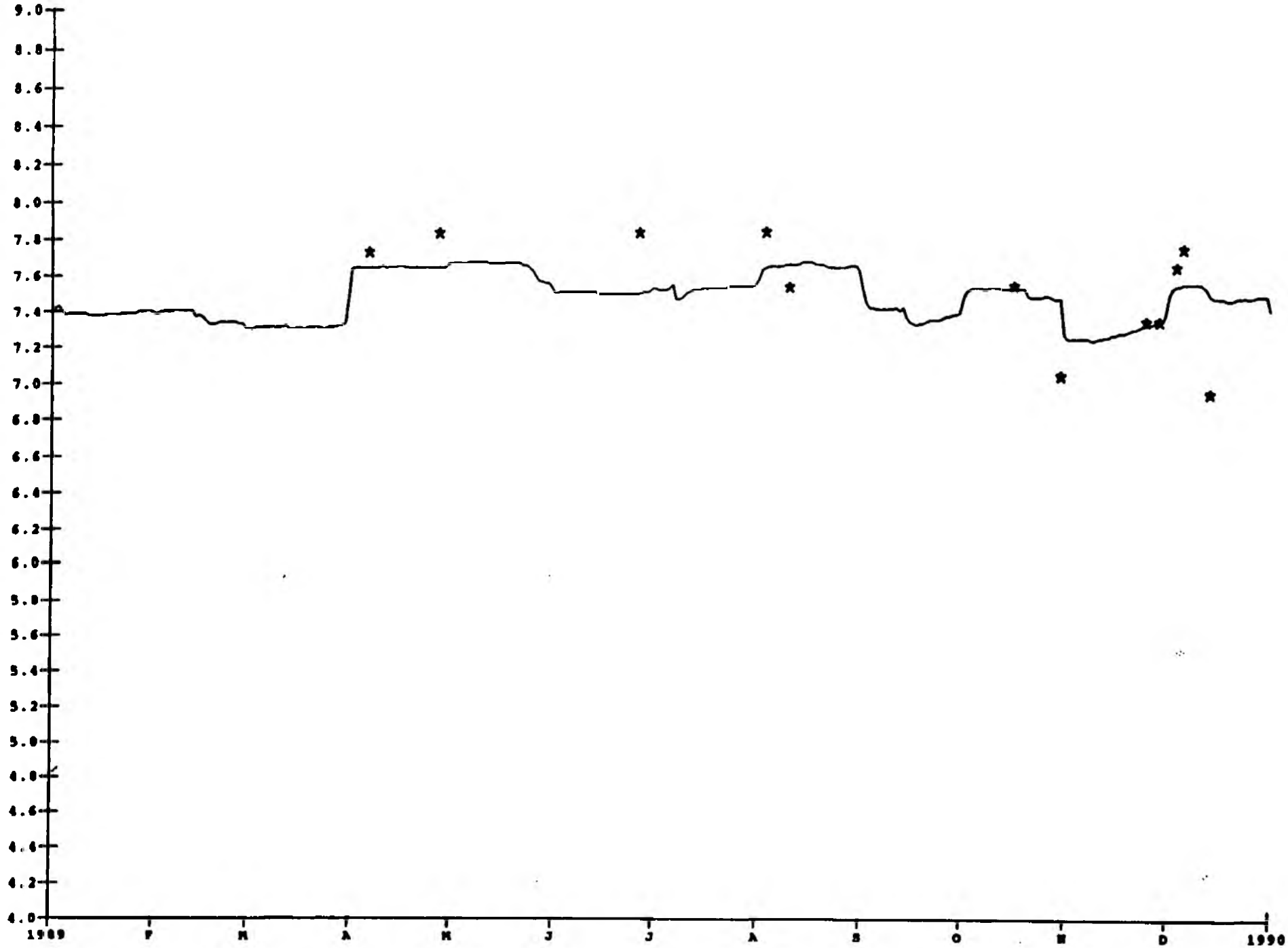
pH at Colliprieest 1989



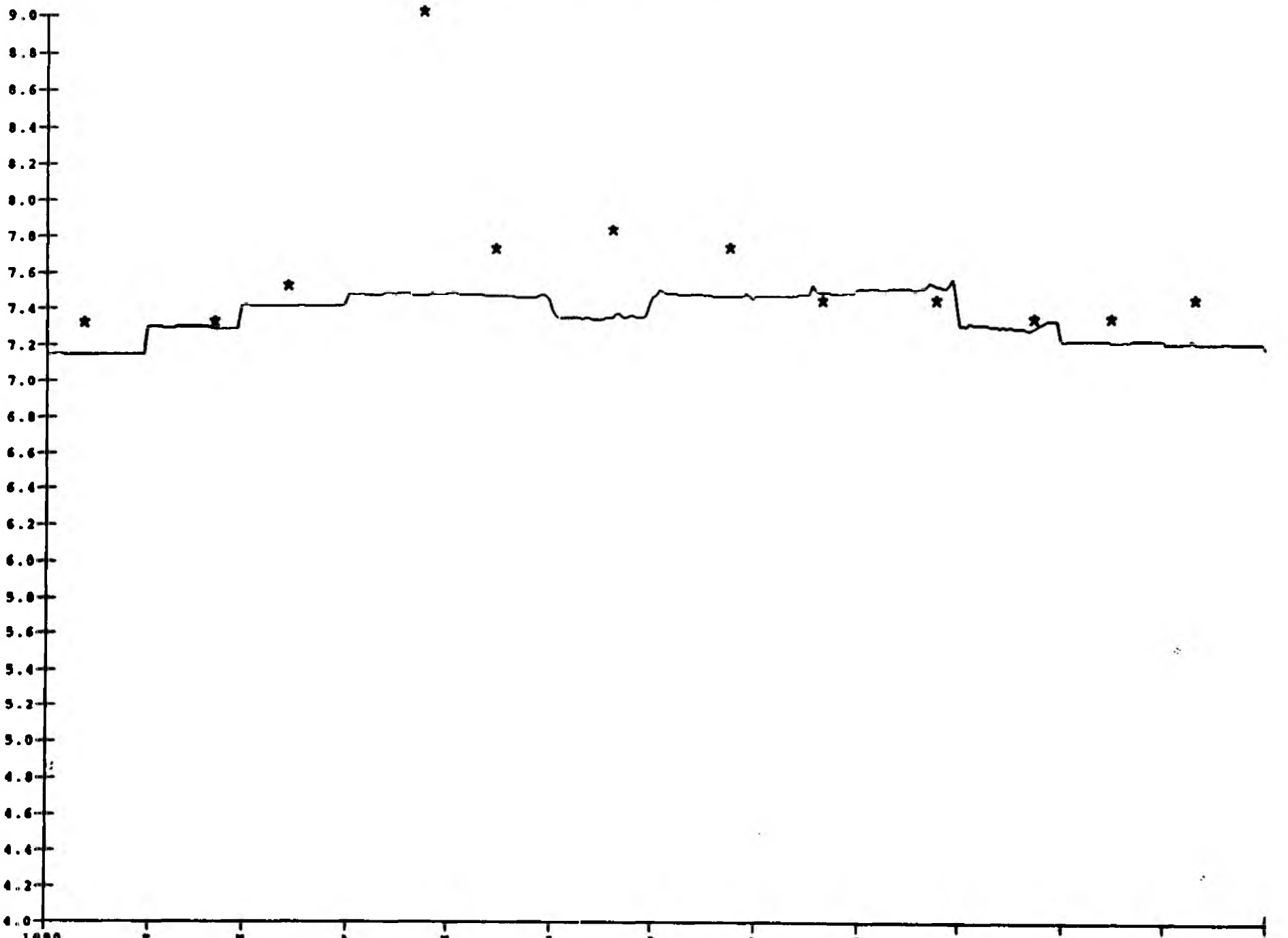
pH at Collipriest 1990



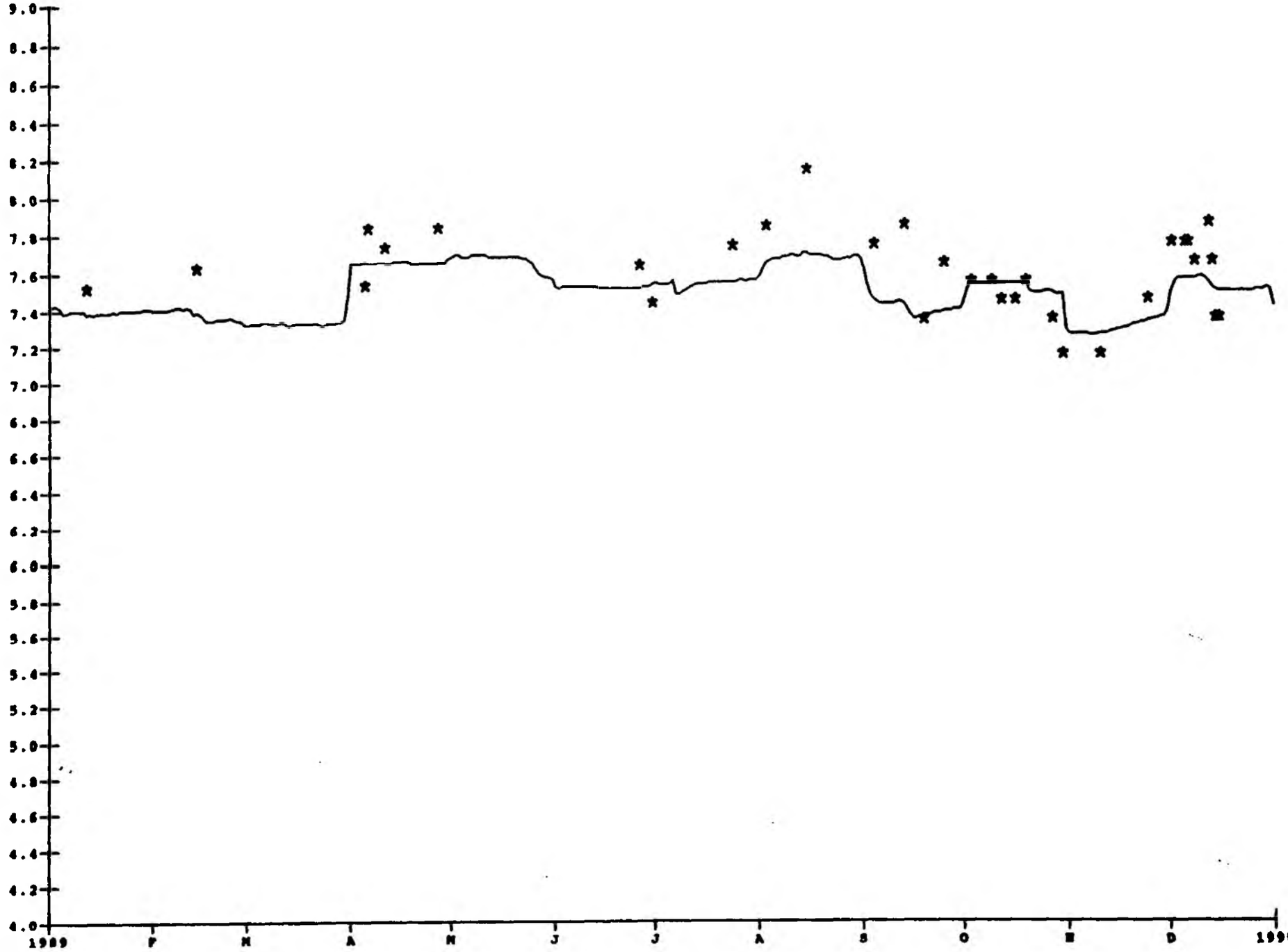
pH at Ashley 1989



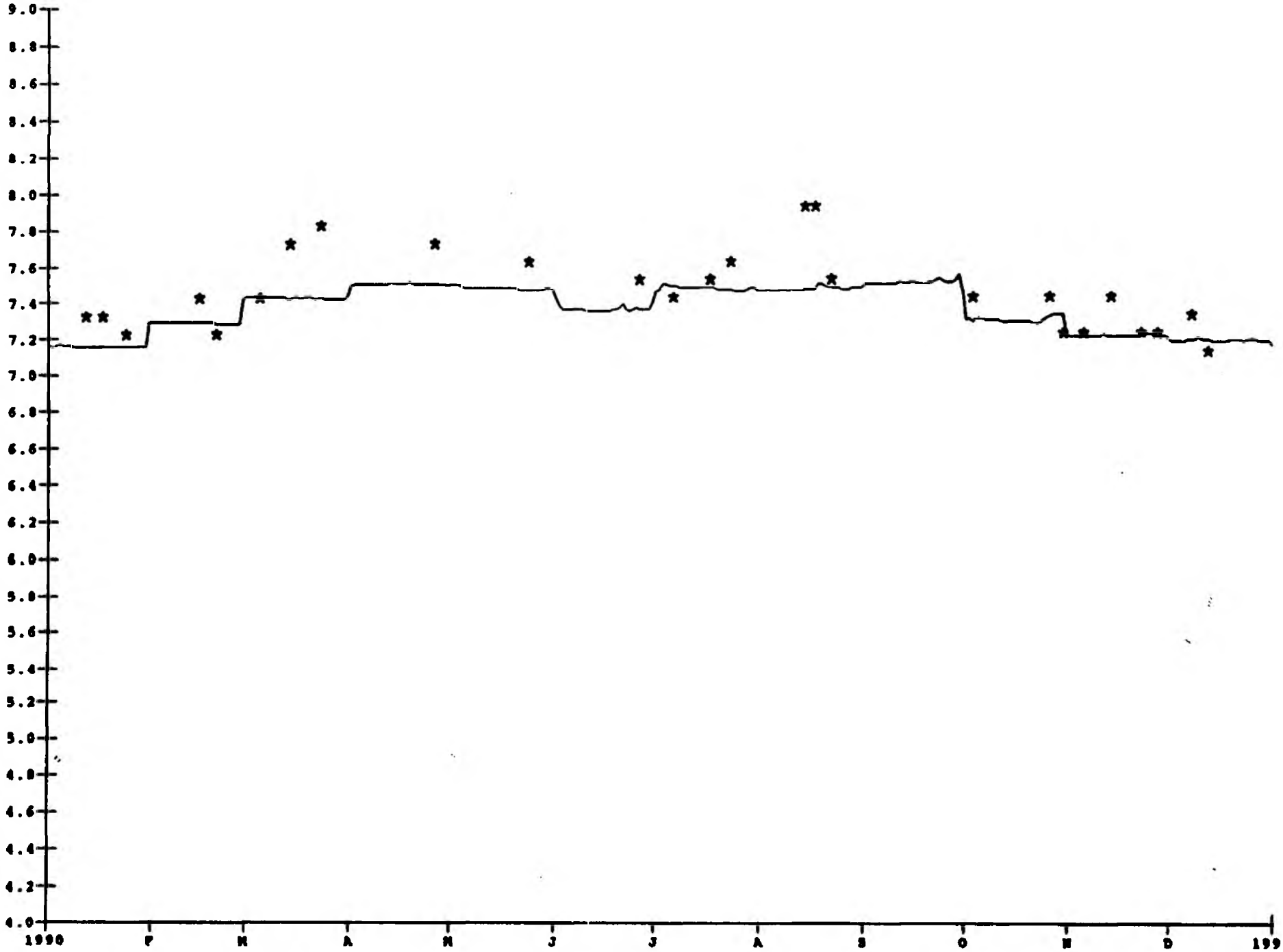
pH at Ashley 1990



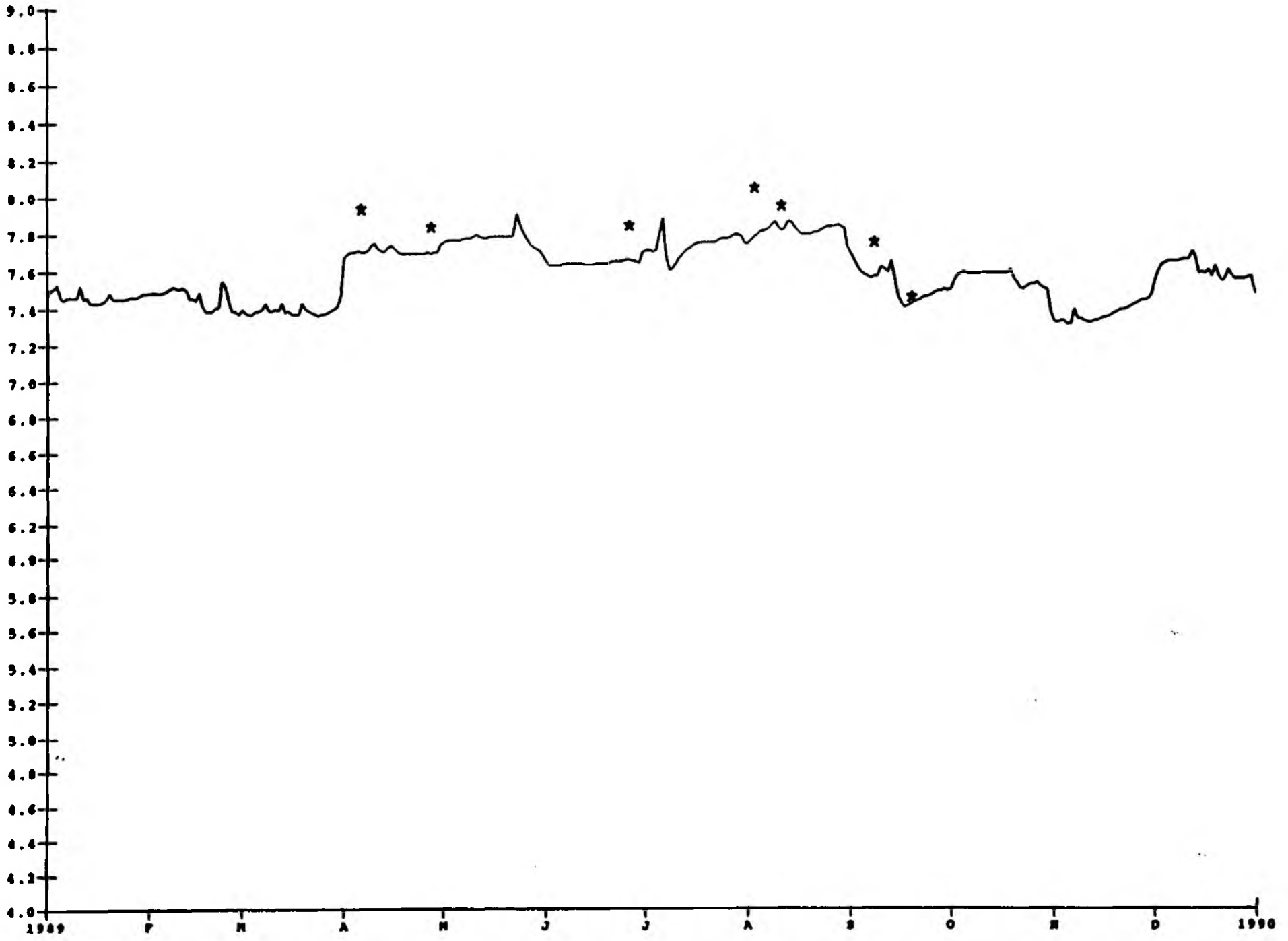
pH at Thorveton 1989



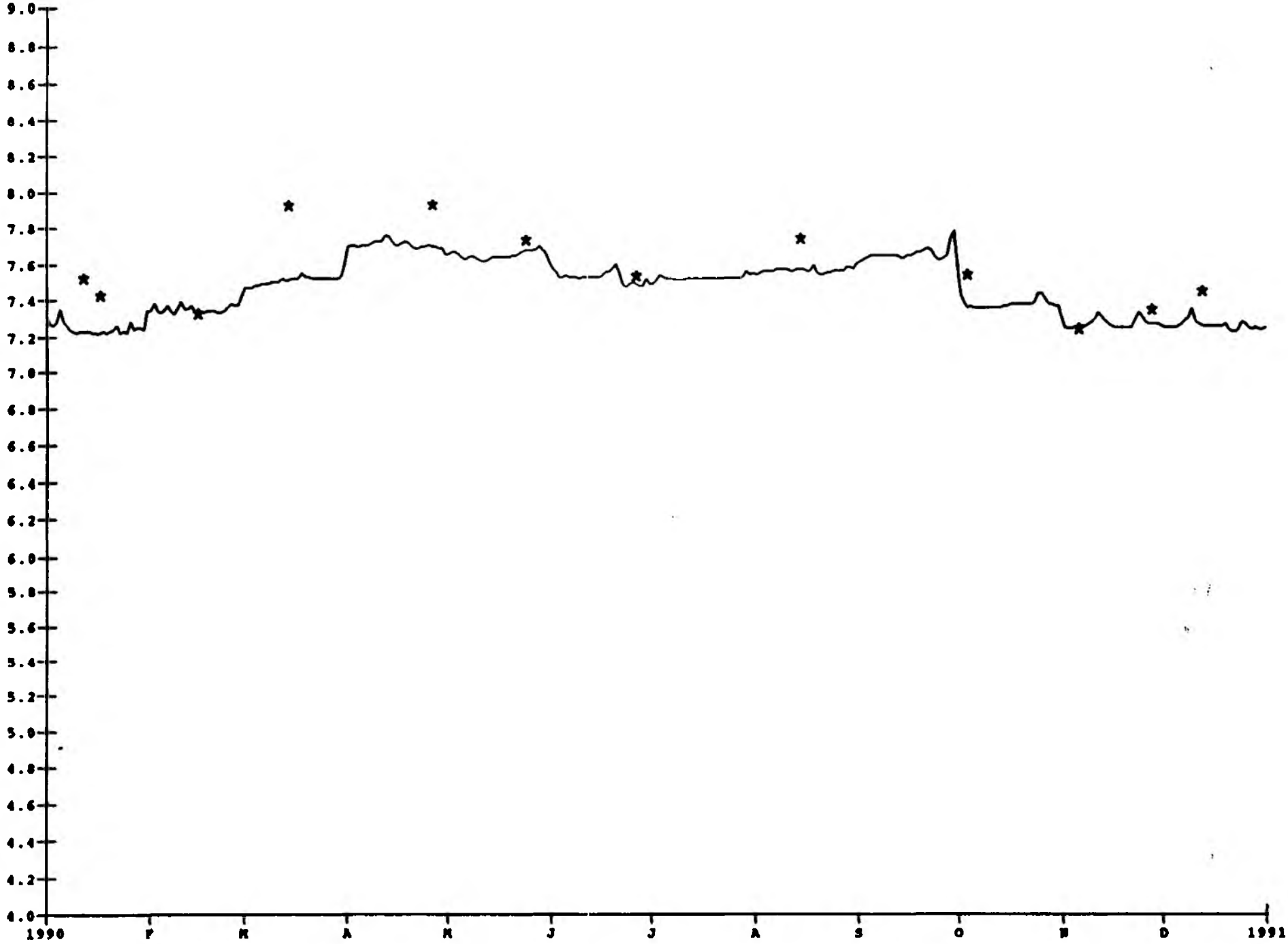
pH at Thorverton 1990



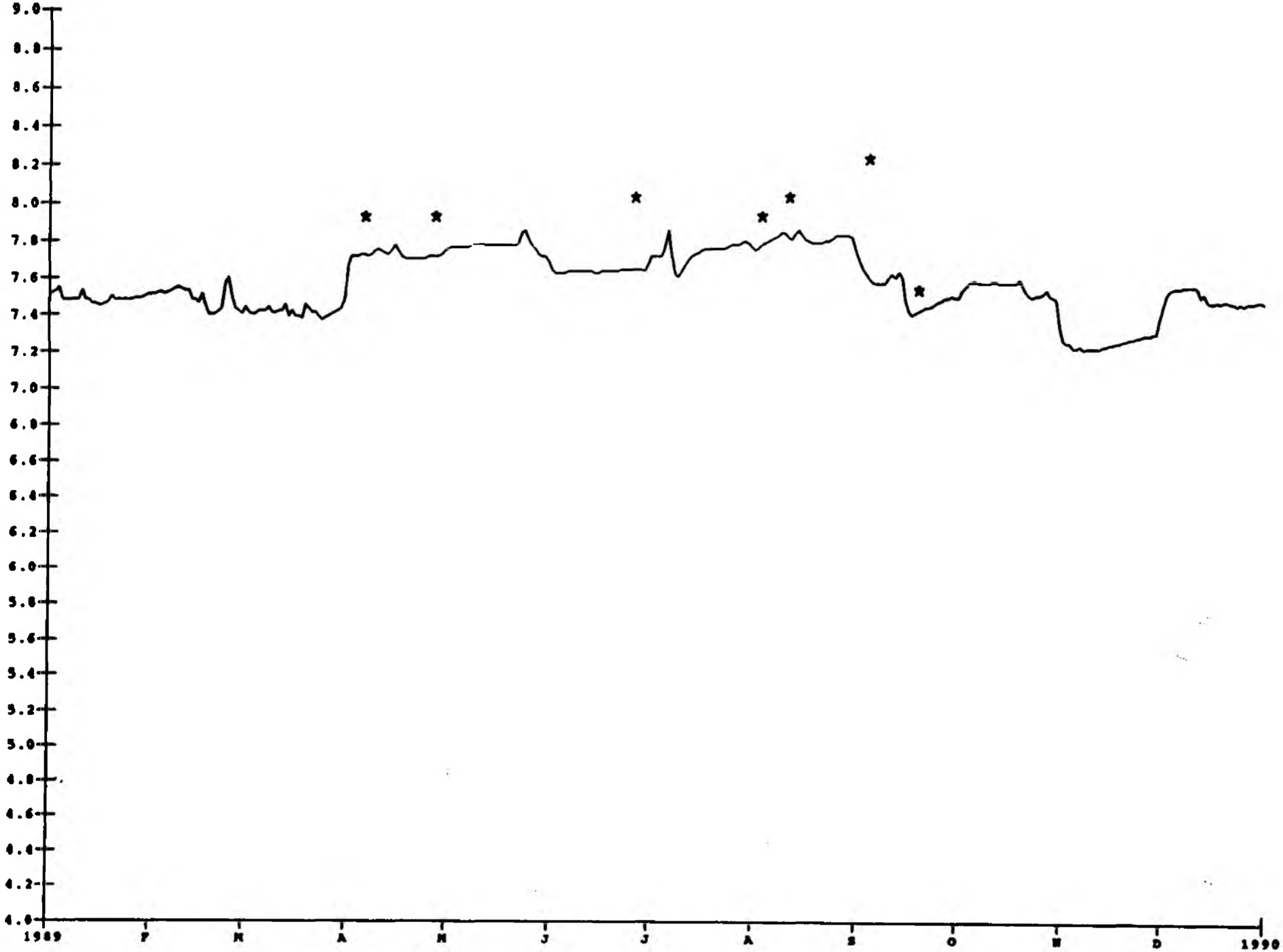
pH at Stafford Br. 1989



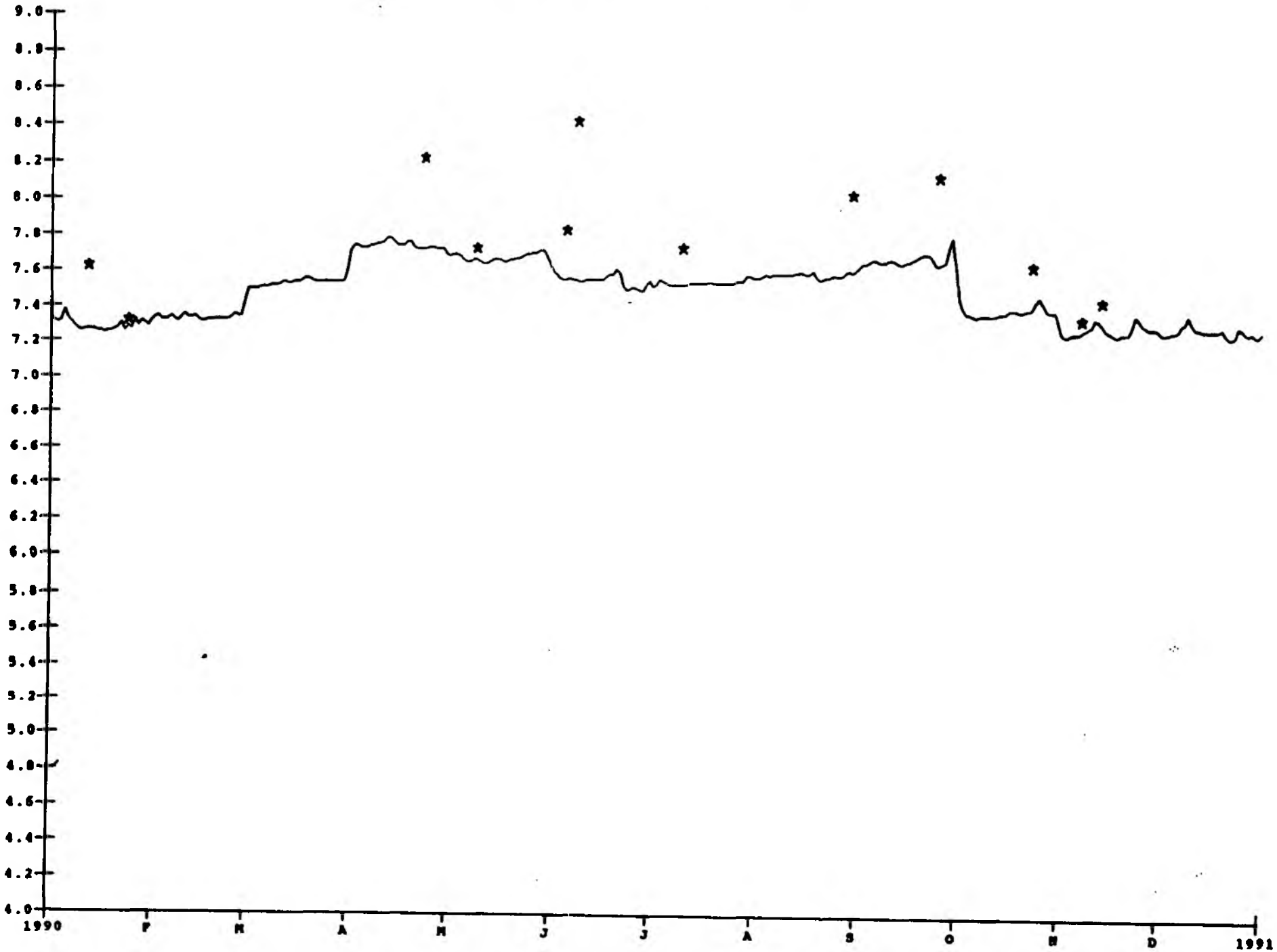
pH at Stafford Br. 1990



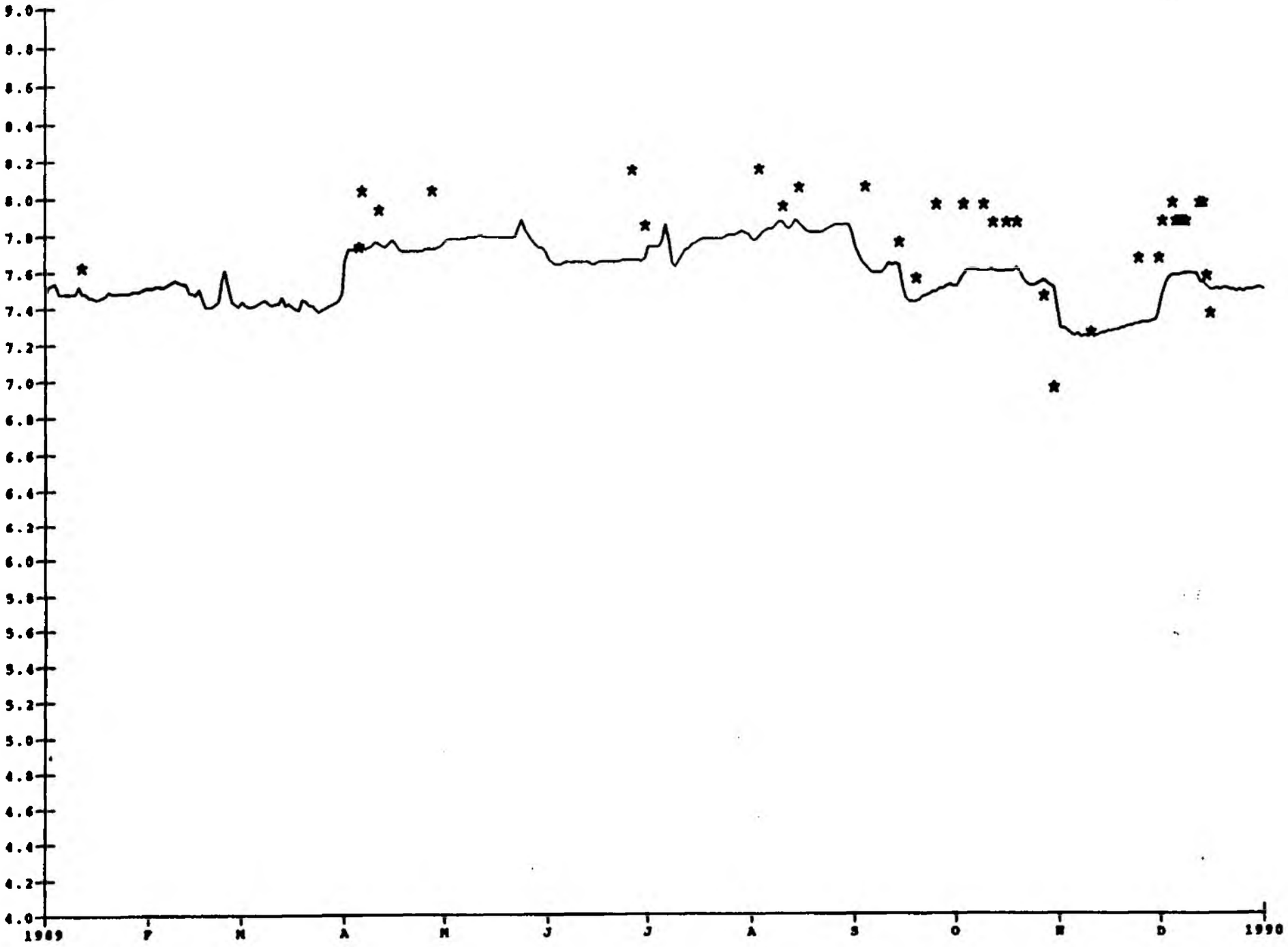
pH at Exwick 1989



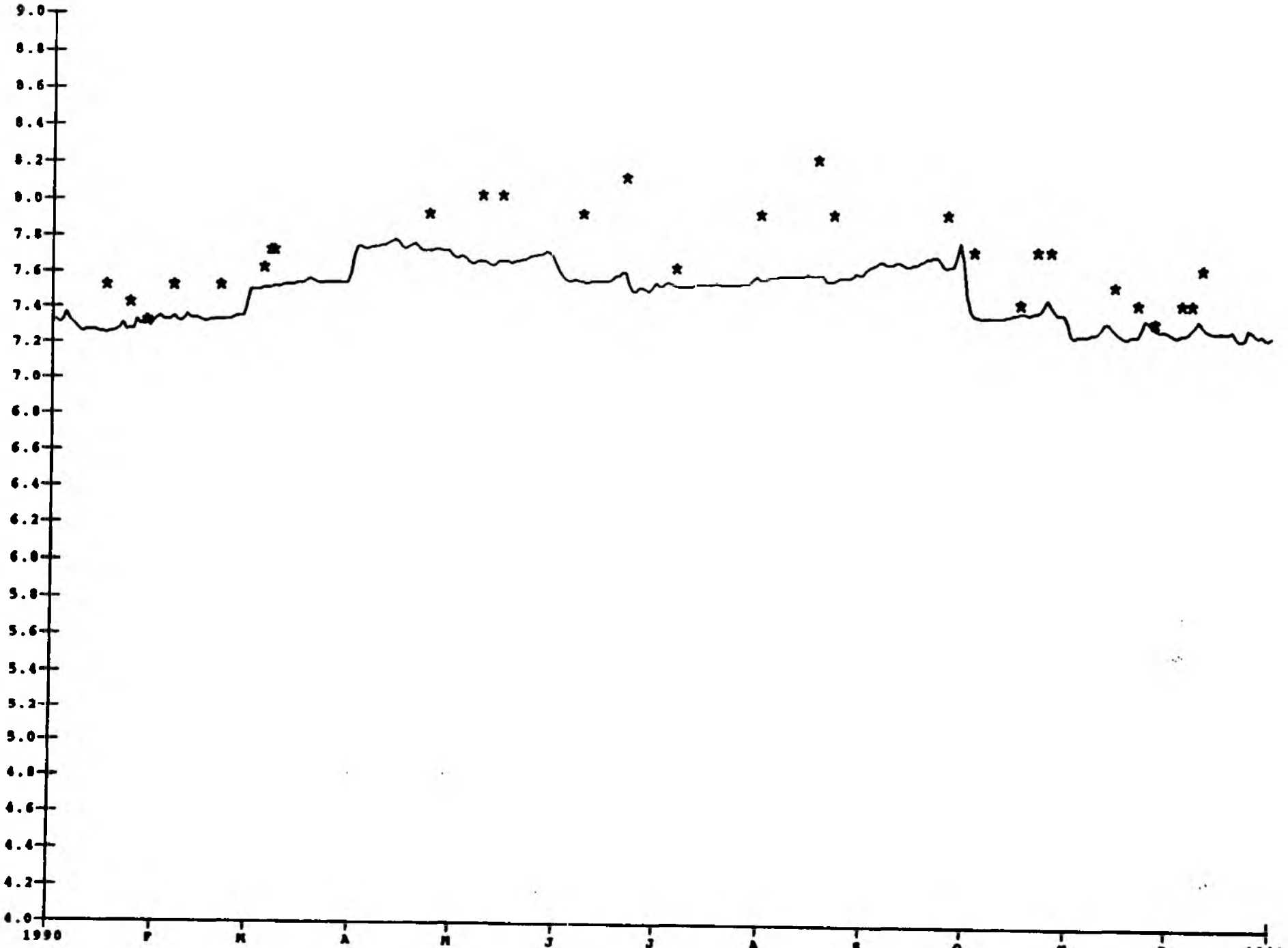
pH at Exwick 1990



pH at Trews Weir 1989



pH at Trews Well 1990



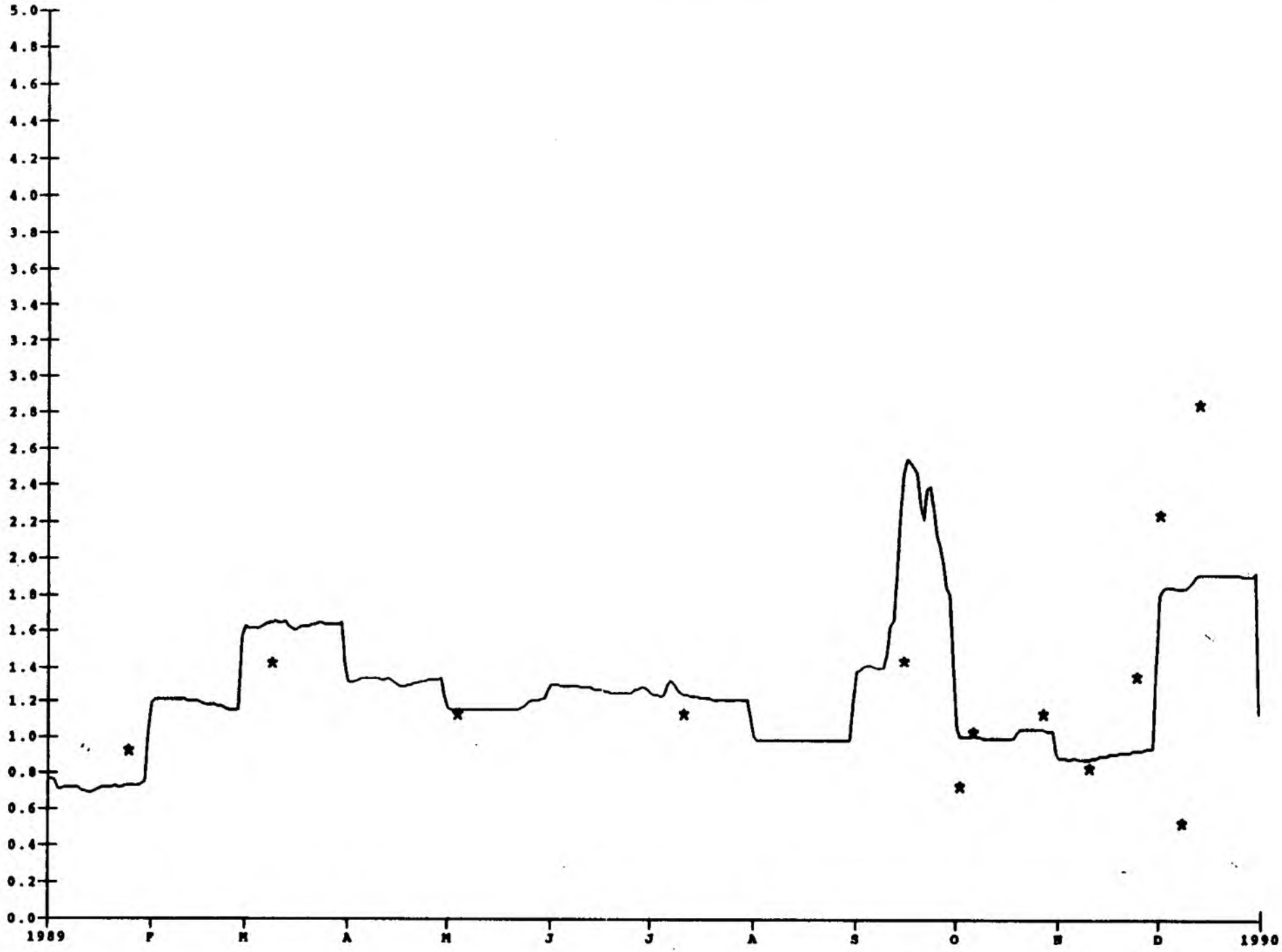
Appendix D - BOD Profiles

Contents:

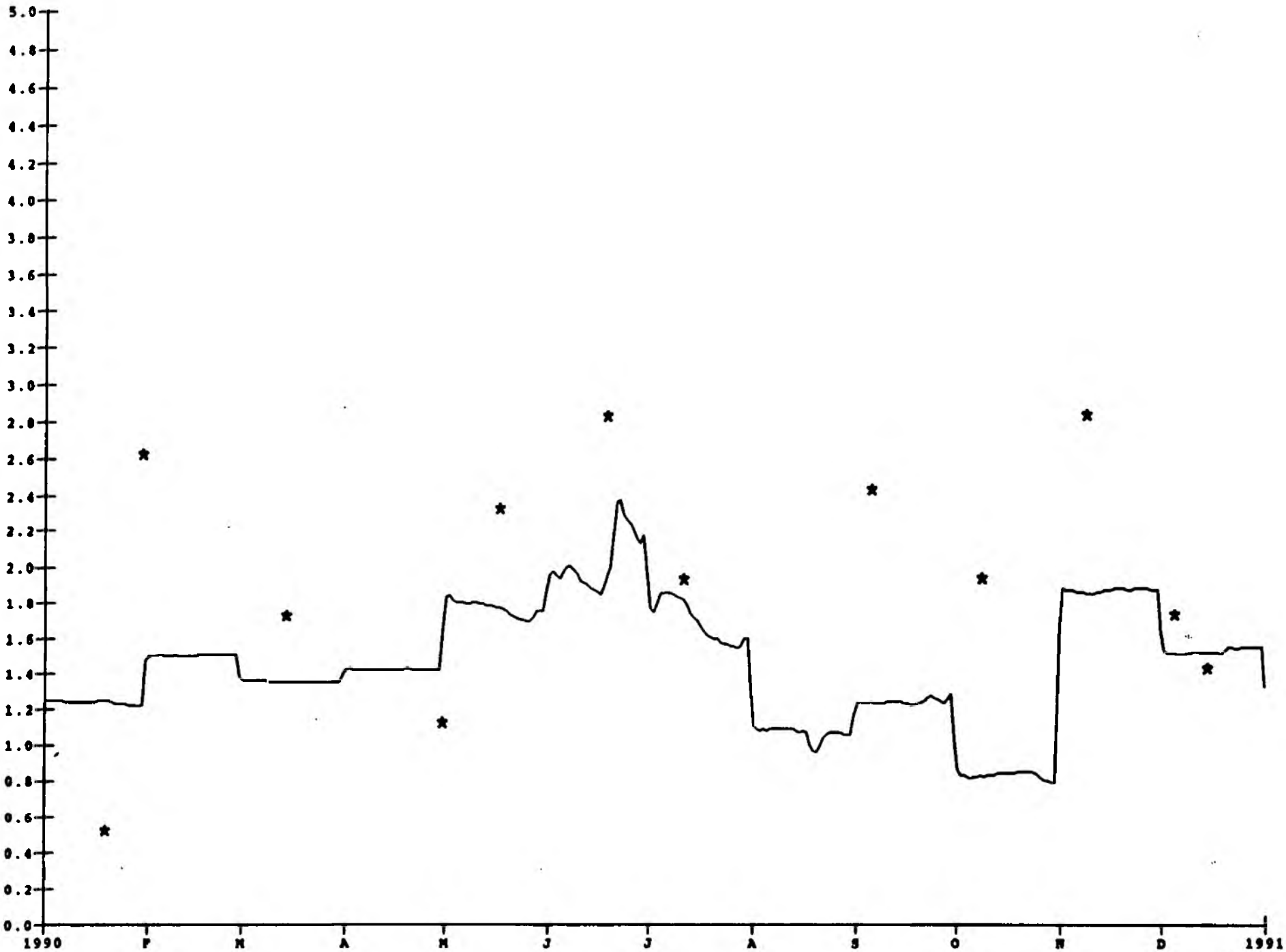
Annual Profiles for:

Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

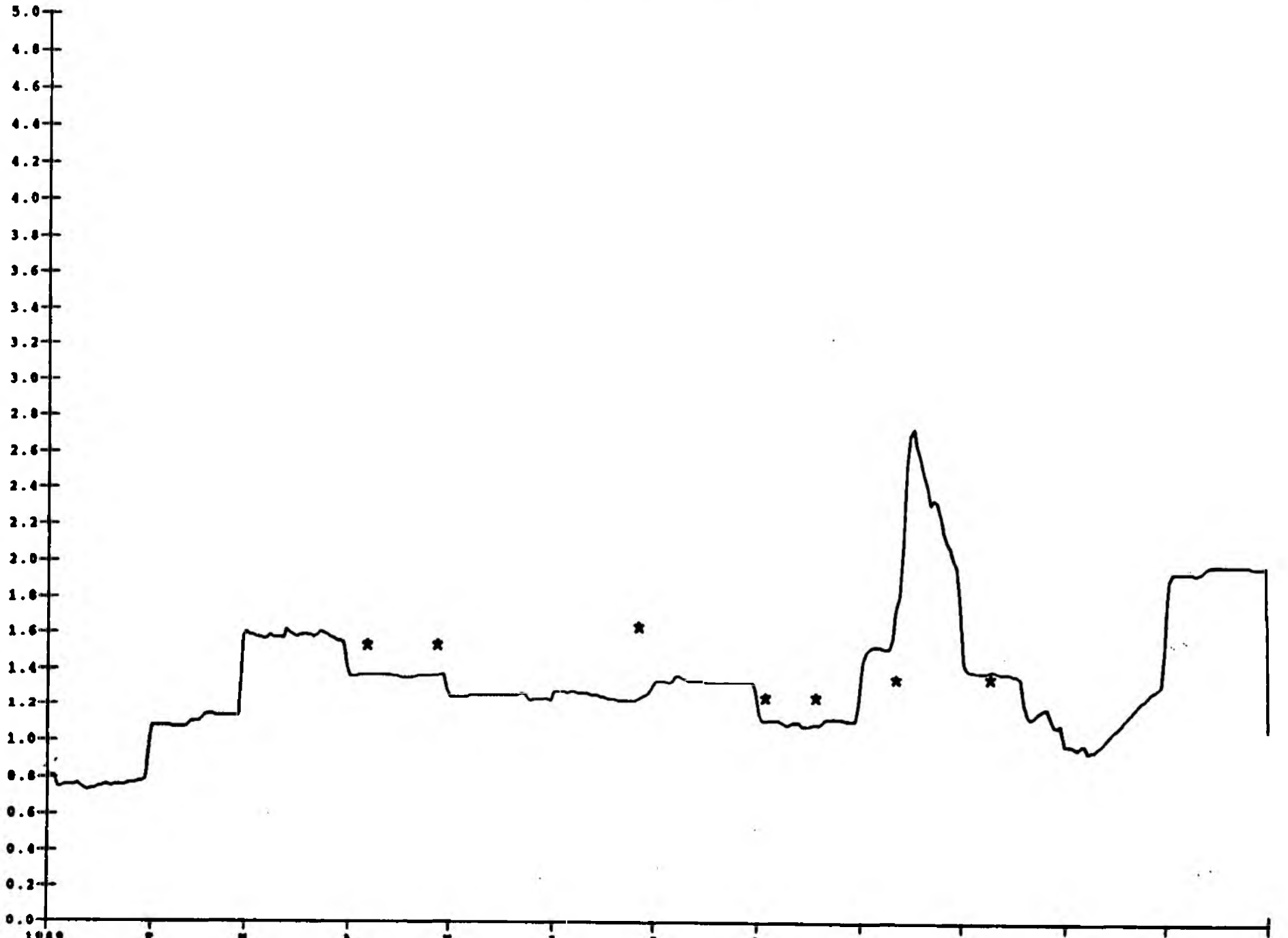
BOD at Pixton 1989



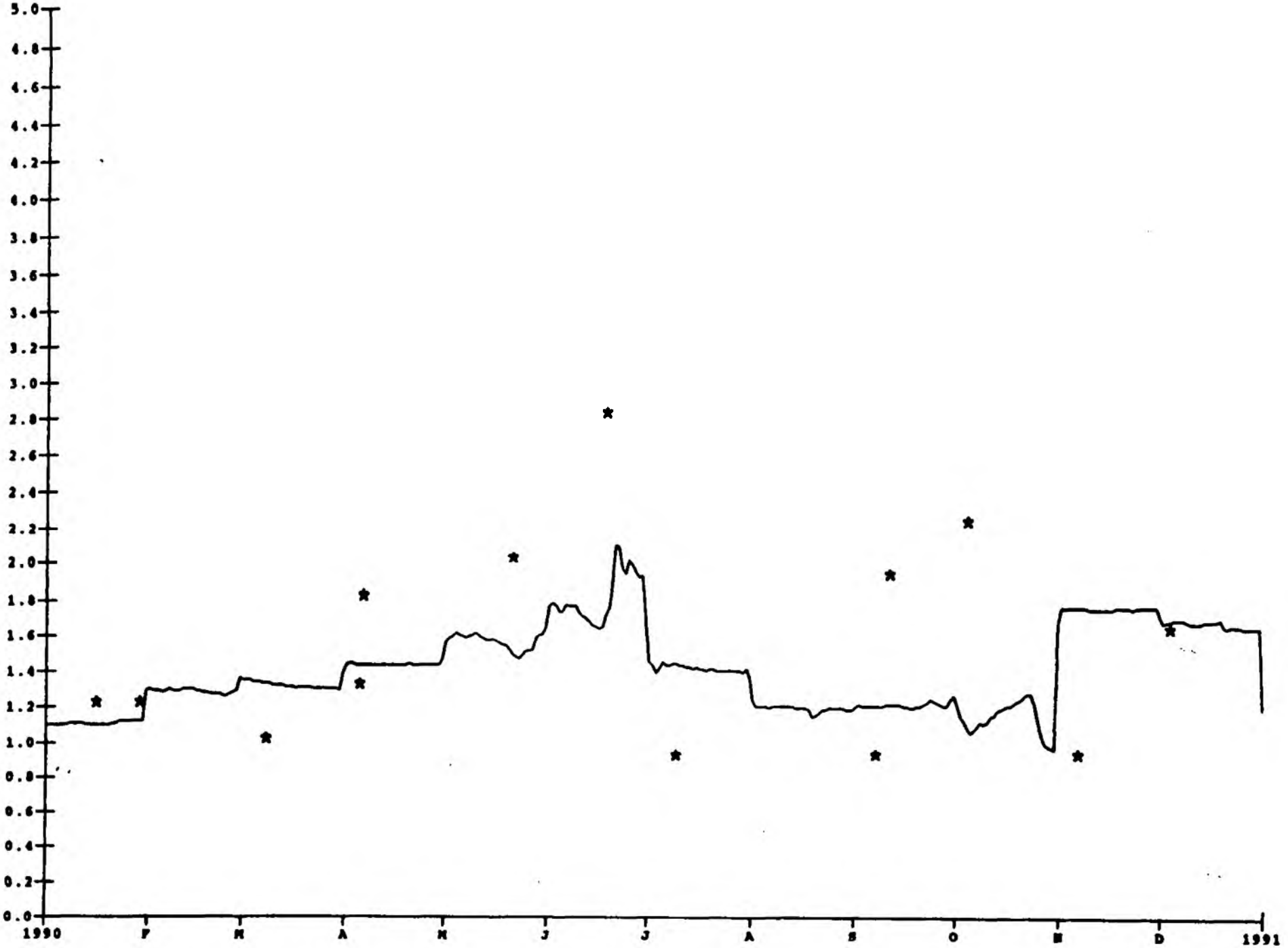
BOD at Pixton 1990



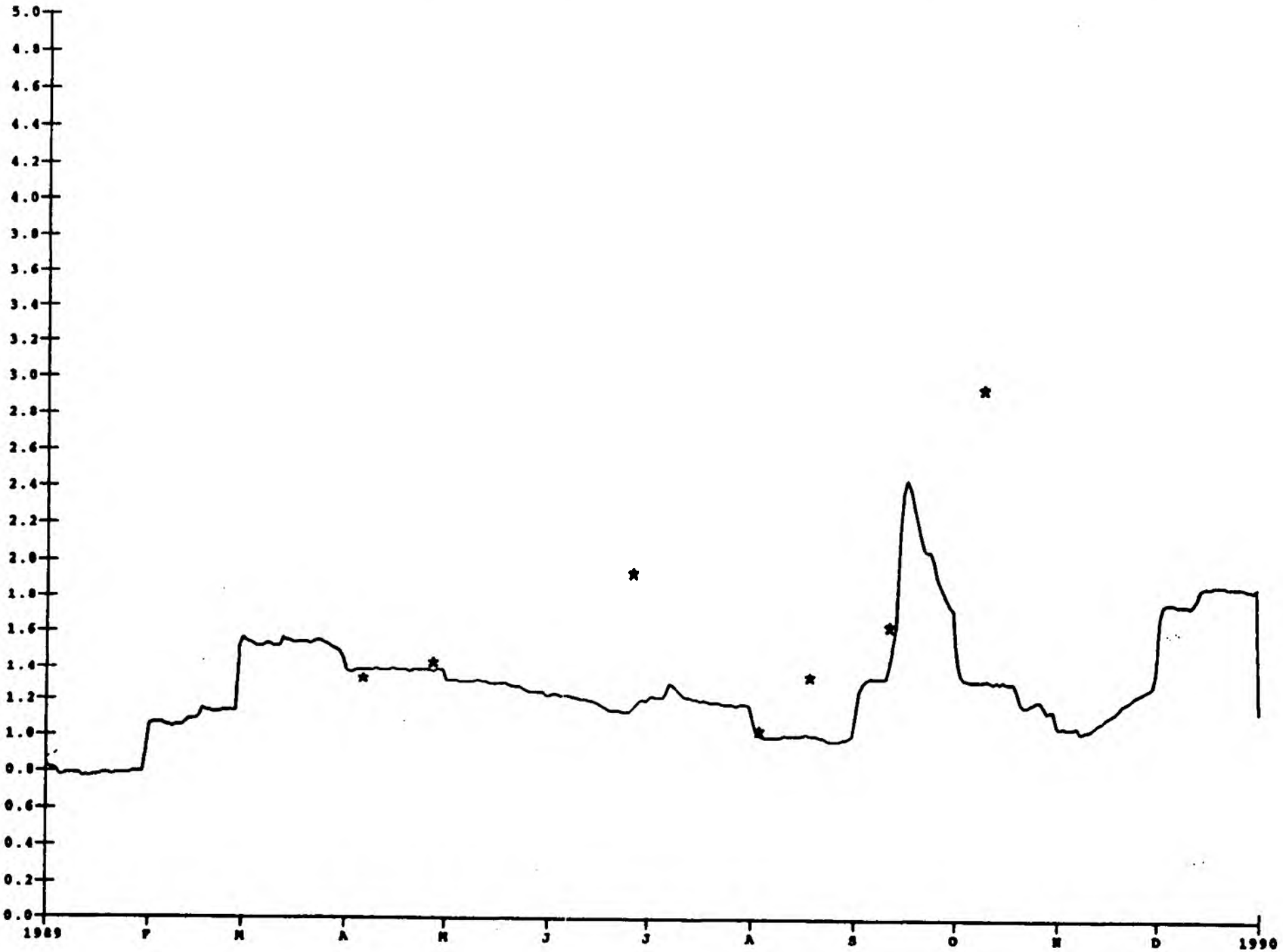
BOB at Halfpenny 1989



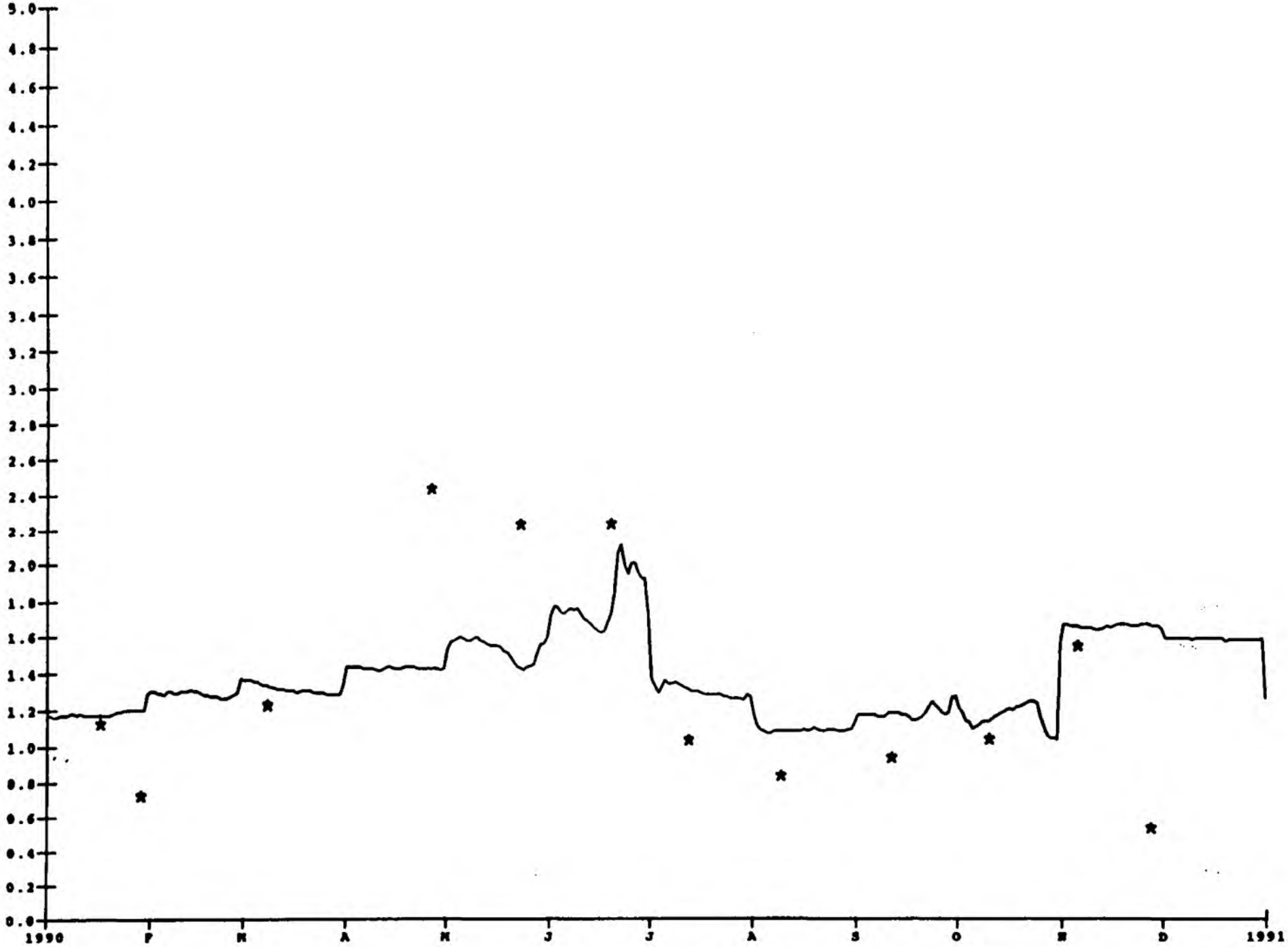
BOD at Halfpenny 1990

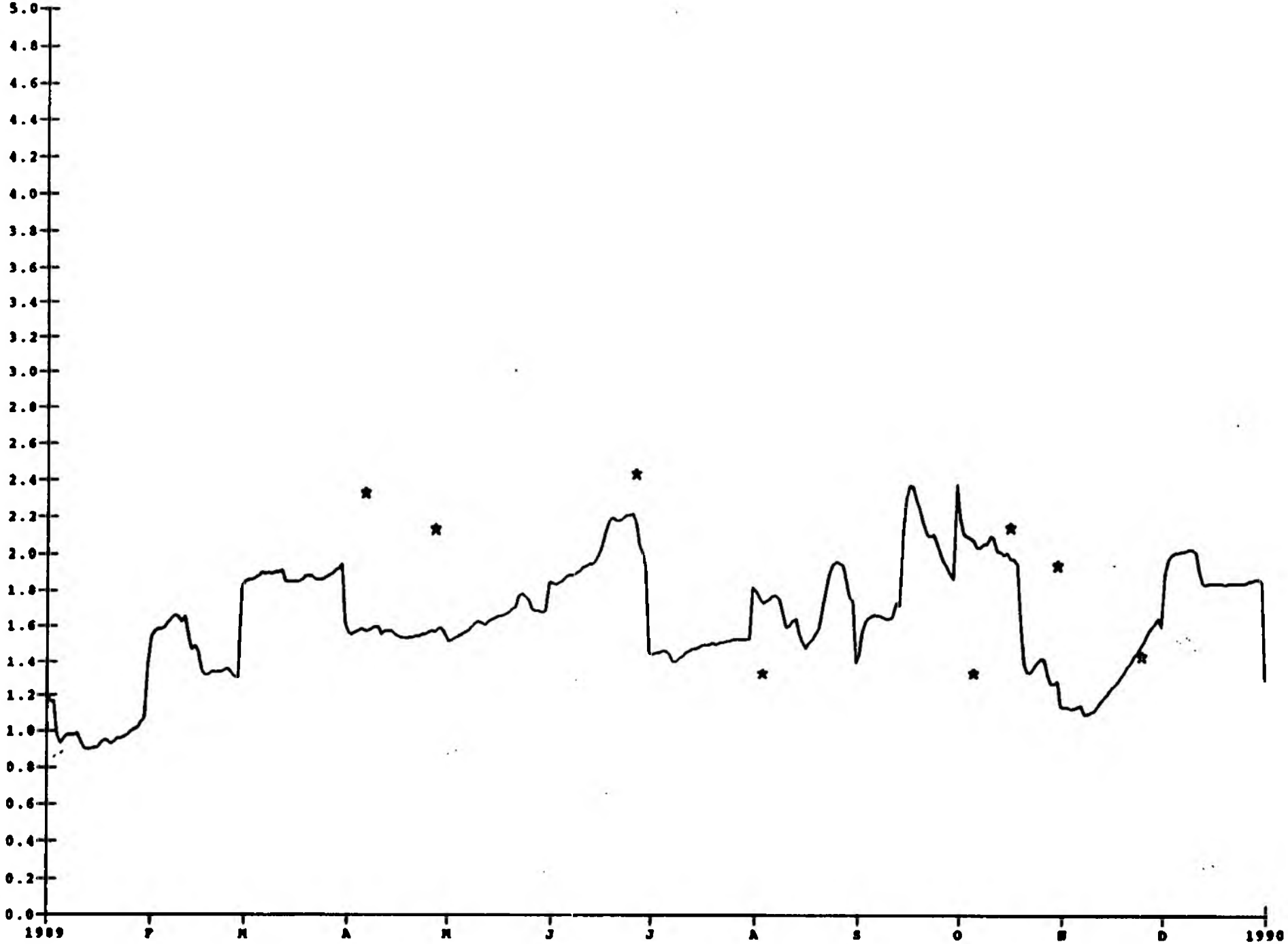


BOD at Tiverton 1989

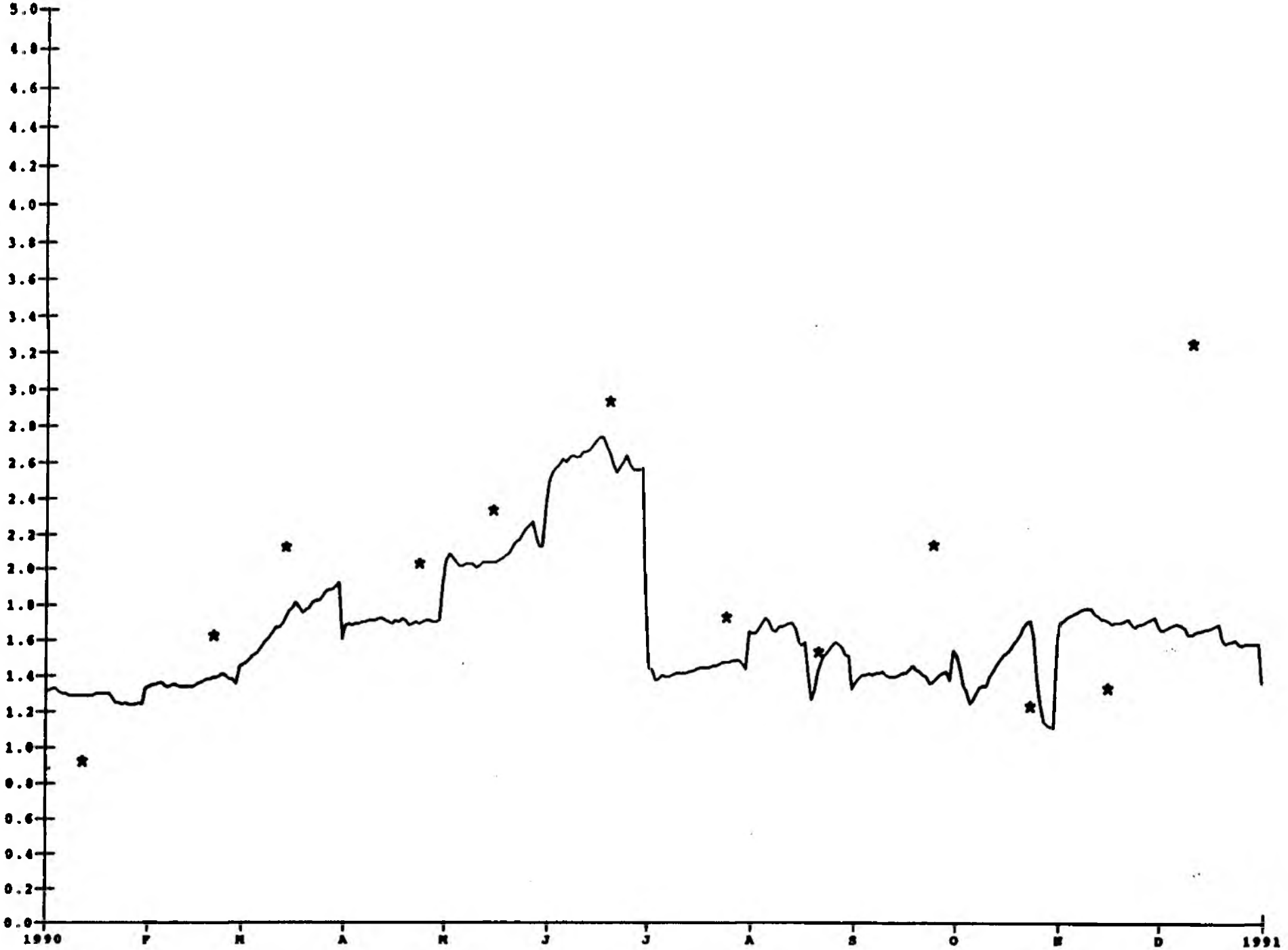


BOD at Tiverton 1990

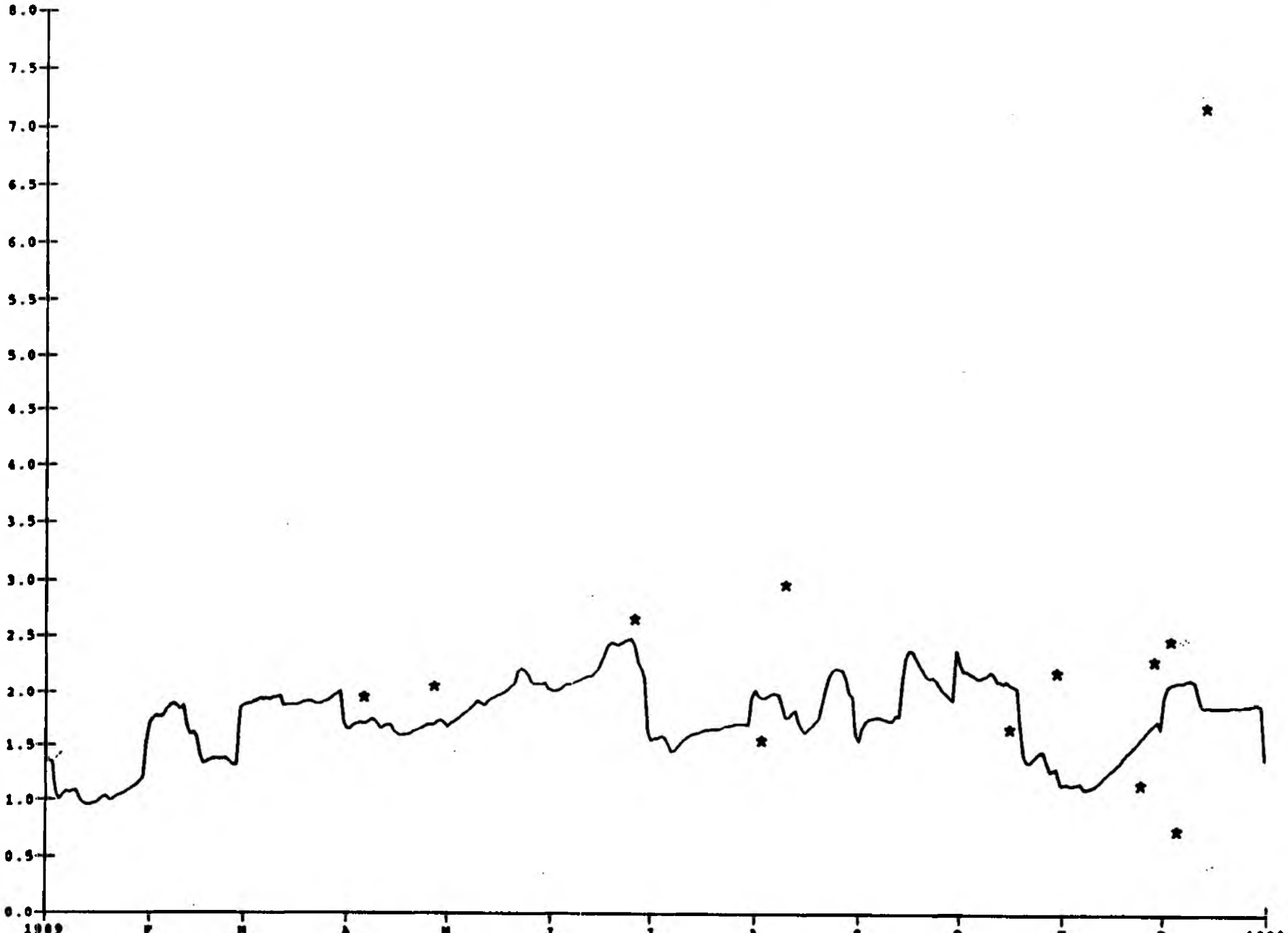




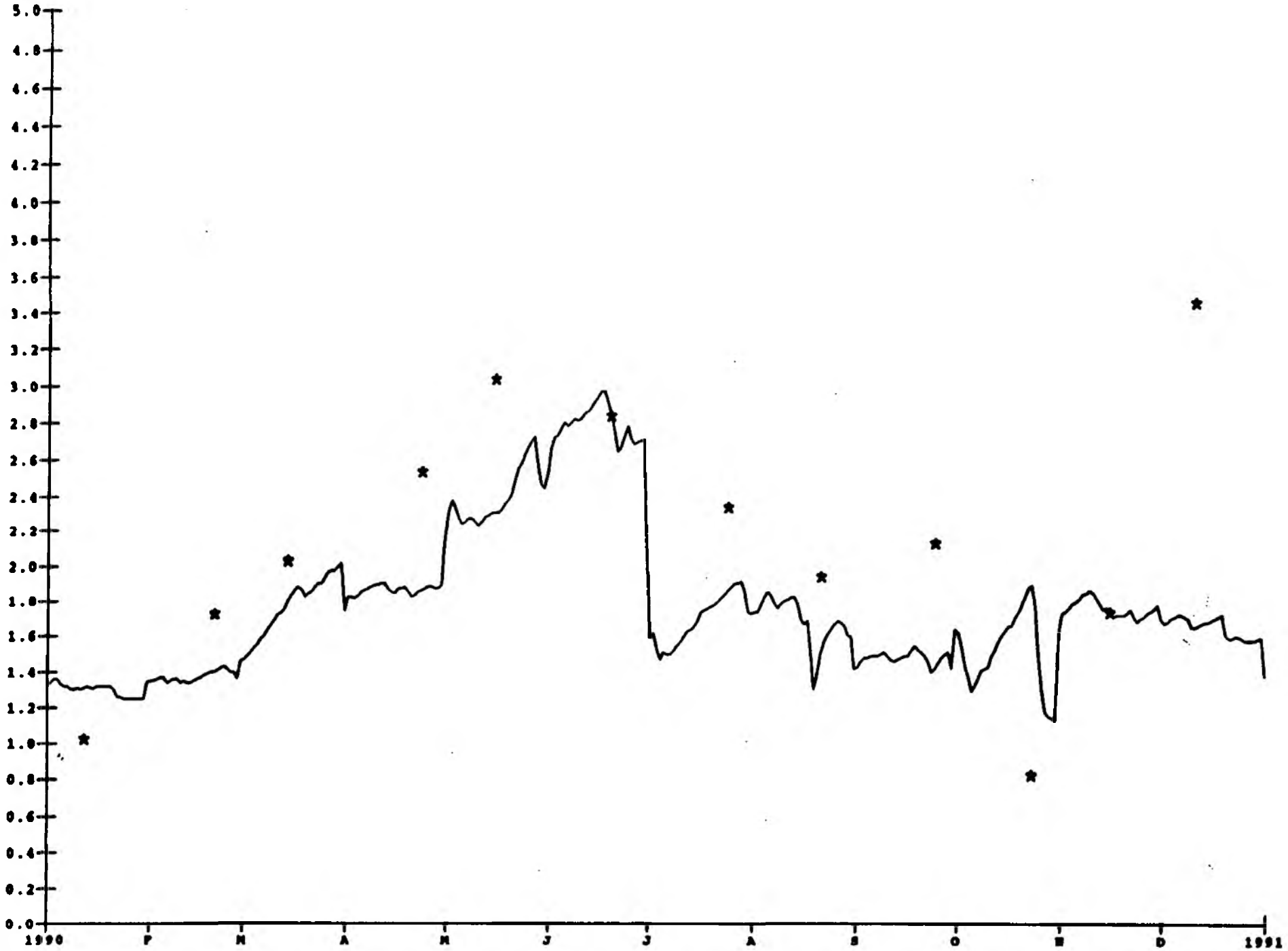
BOD at Colliprlest 1990

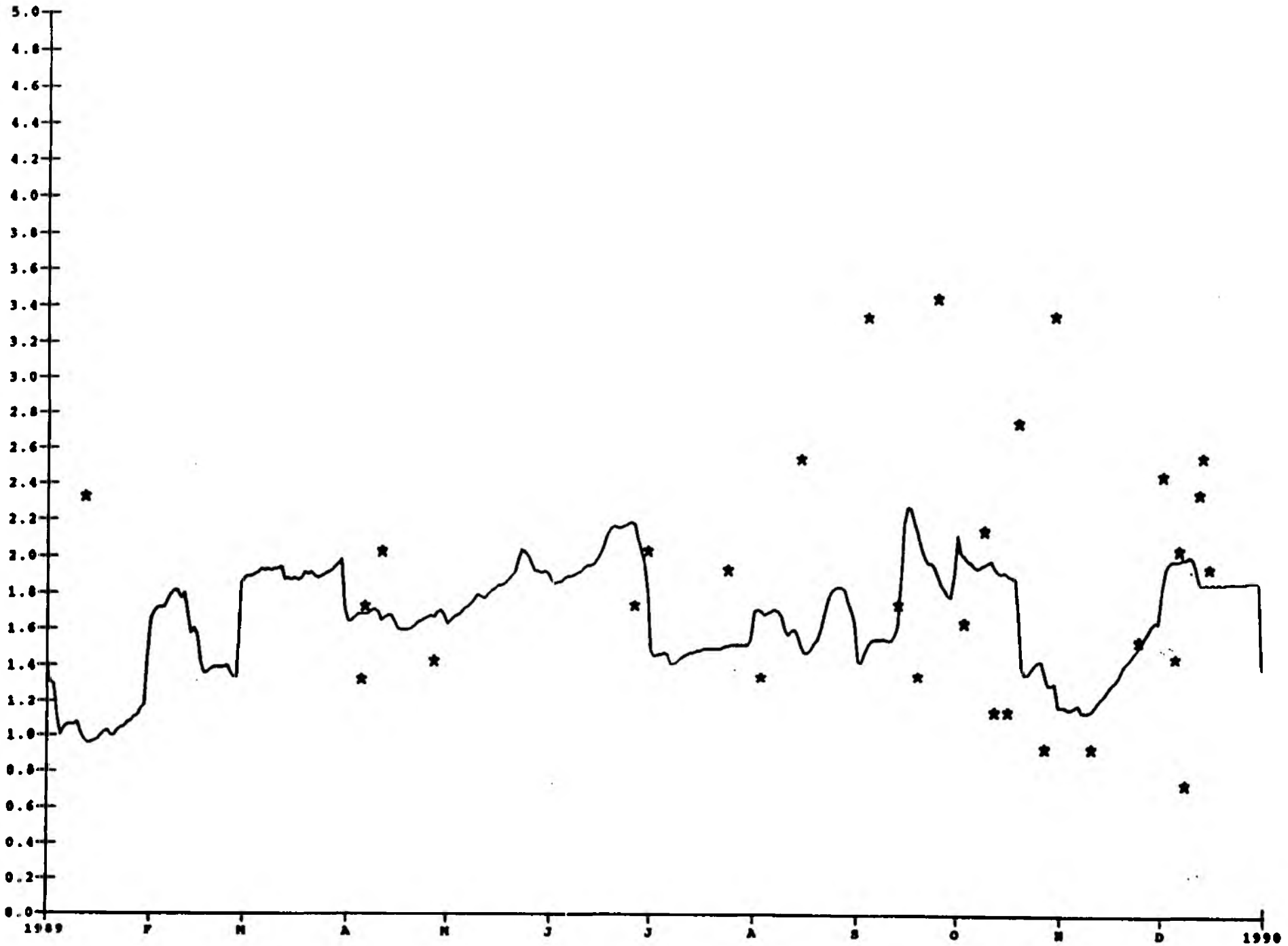


BOD at Ashley 1989

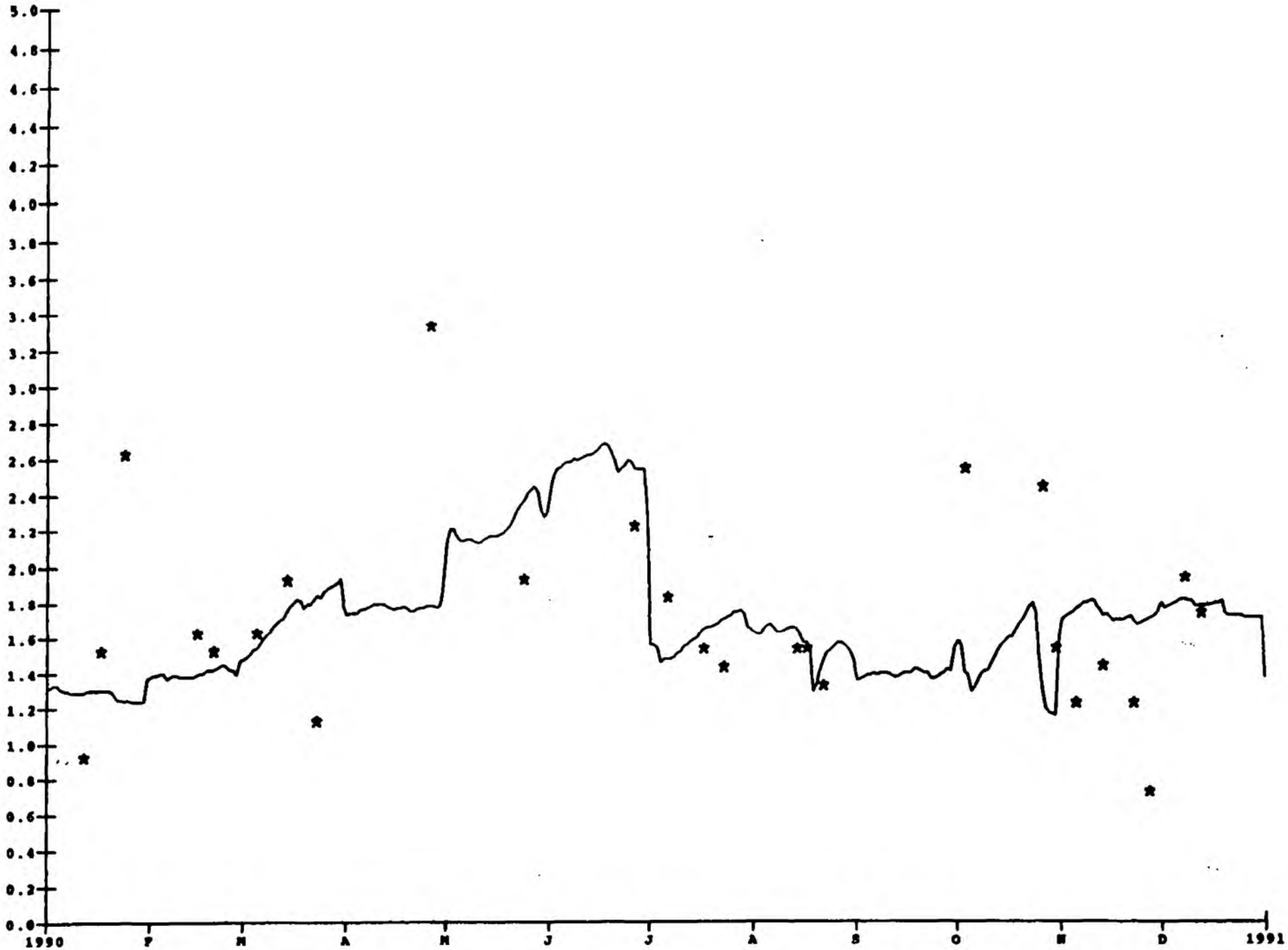


BOD at Ashley 1990

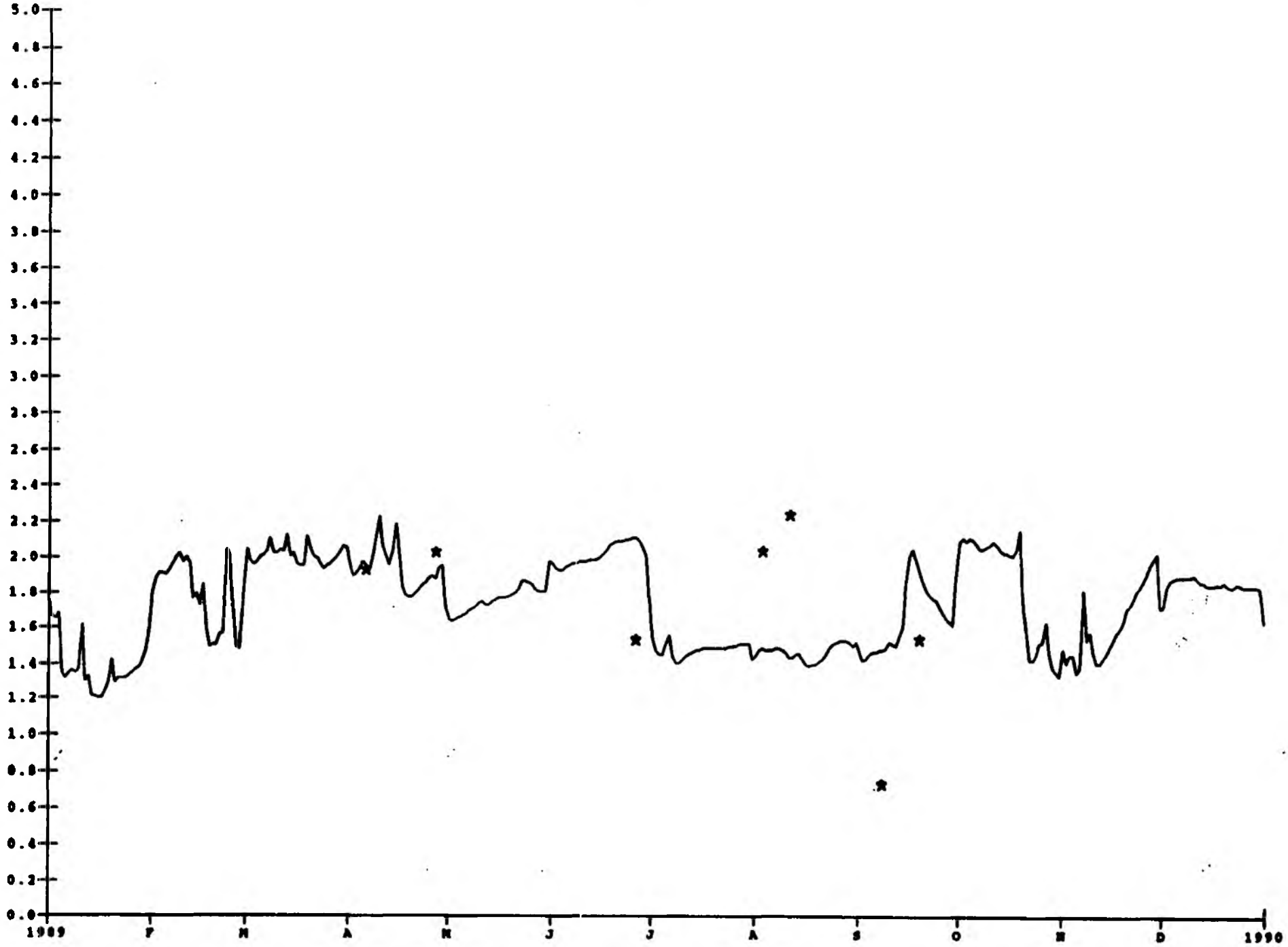



5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1989
F
M
A
M
J
J
A
S
O
N
D
1990

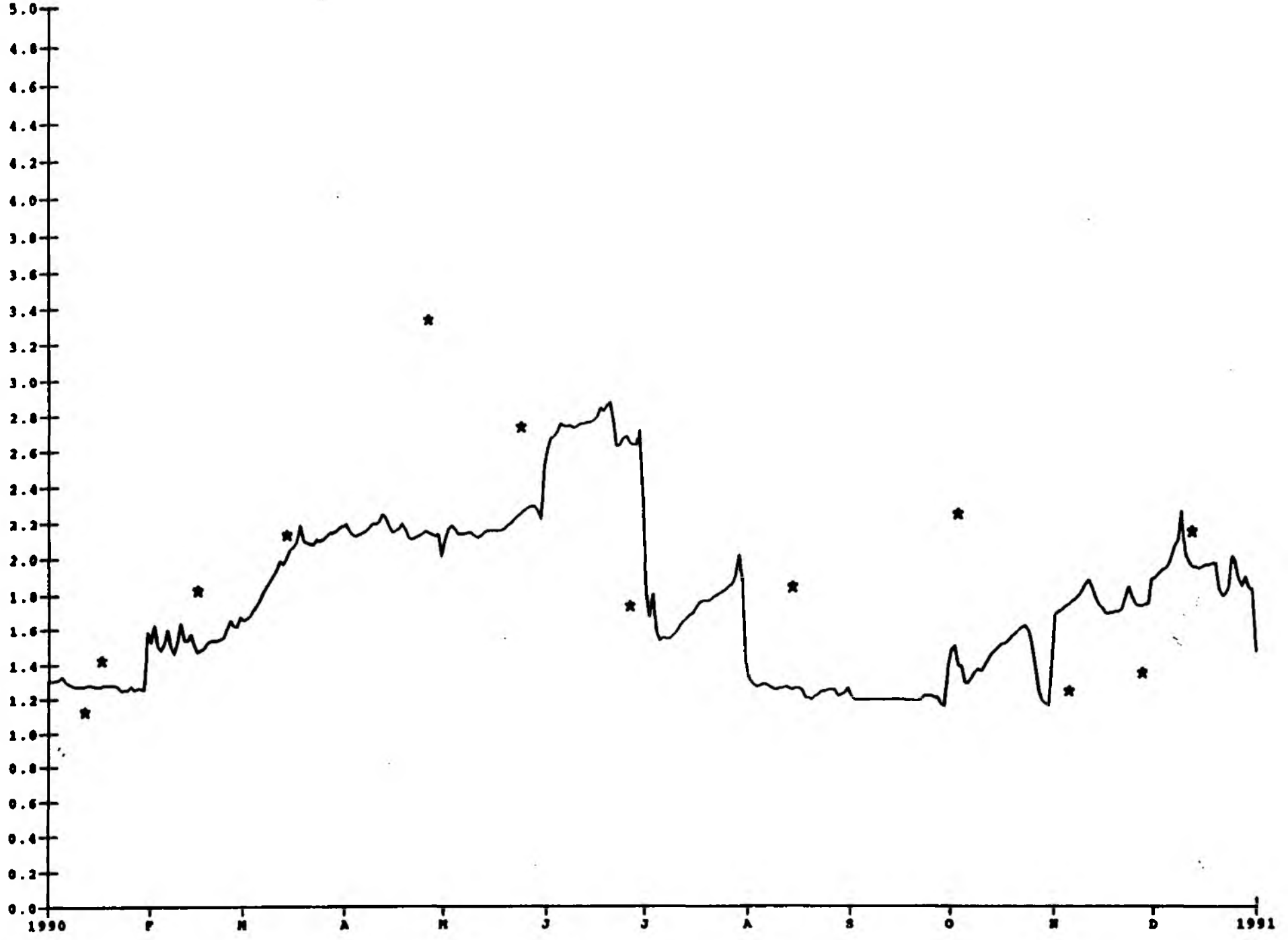
BOD at Thorverton 1990



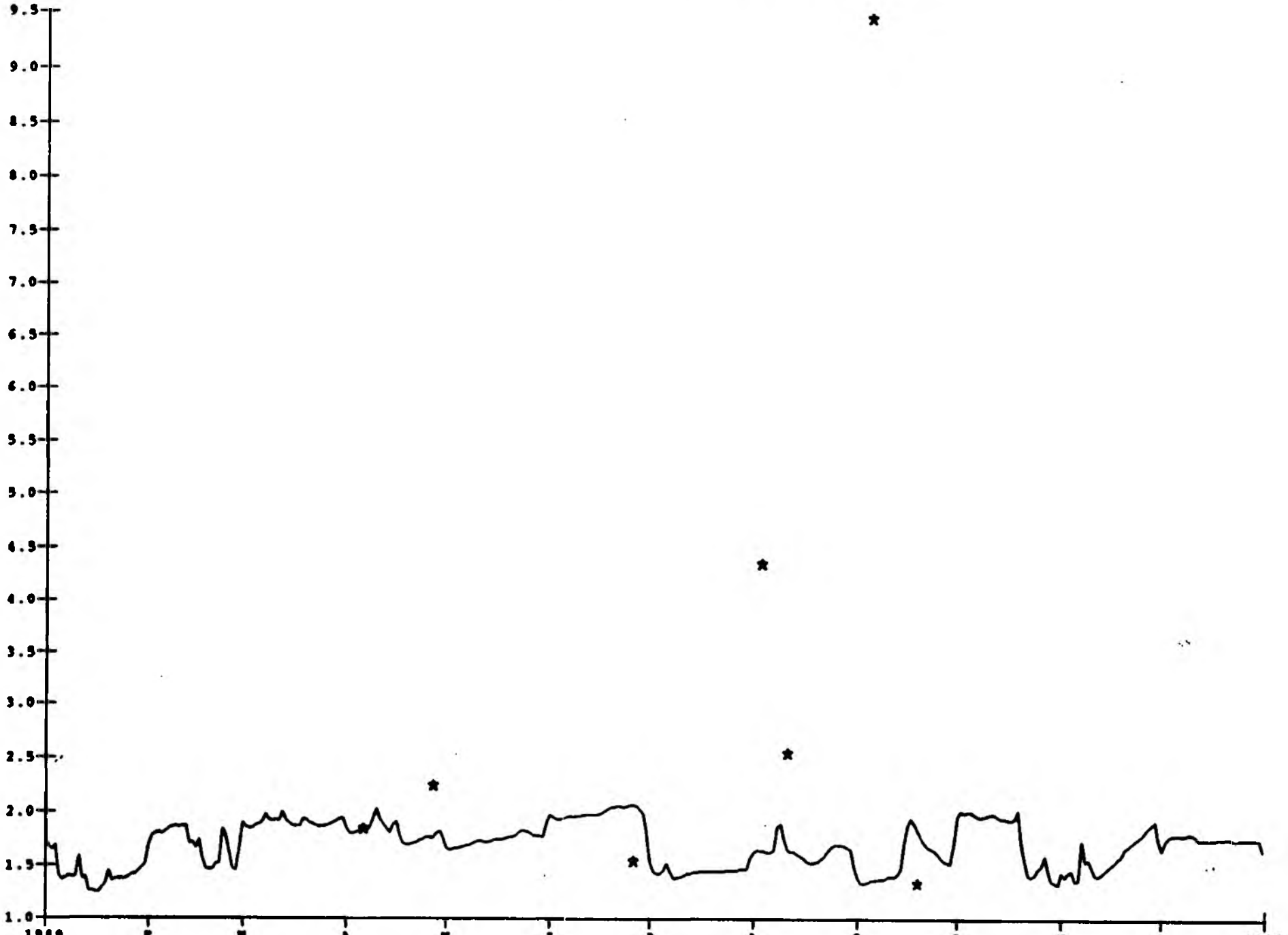
Bob at Stafford Br. 1989



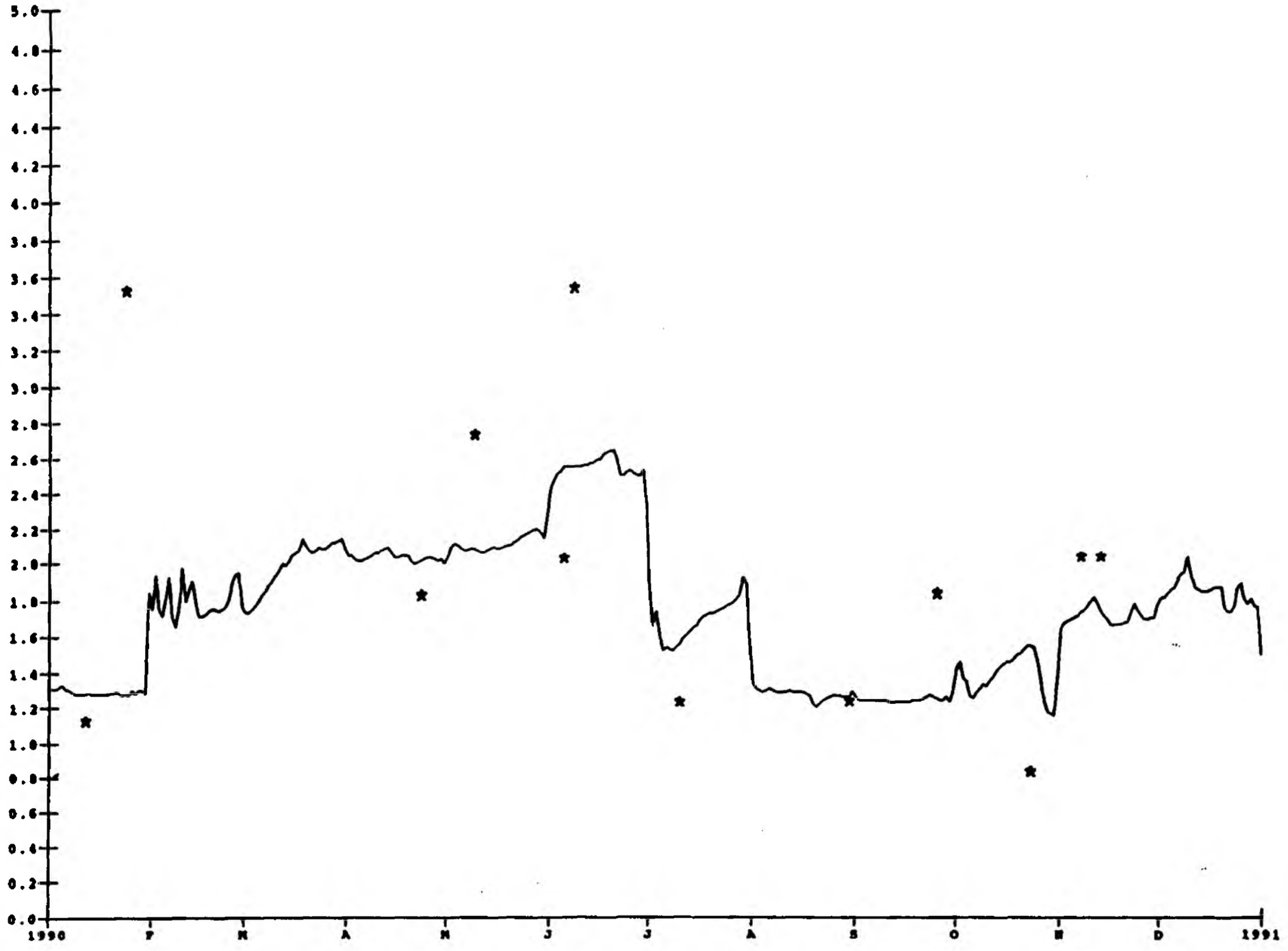
BOD at Stafford Br. 1990



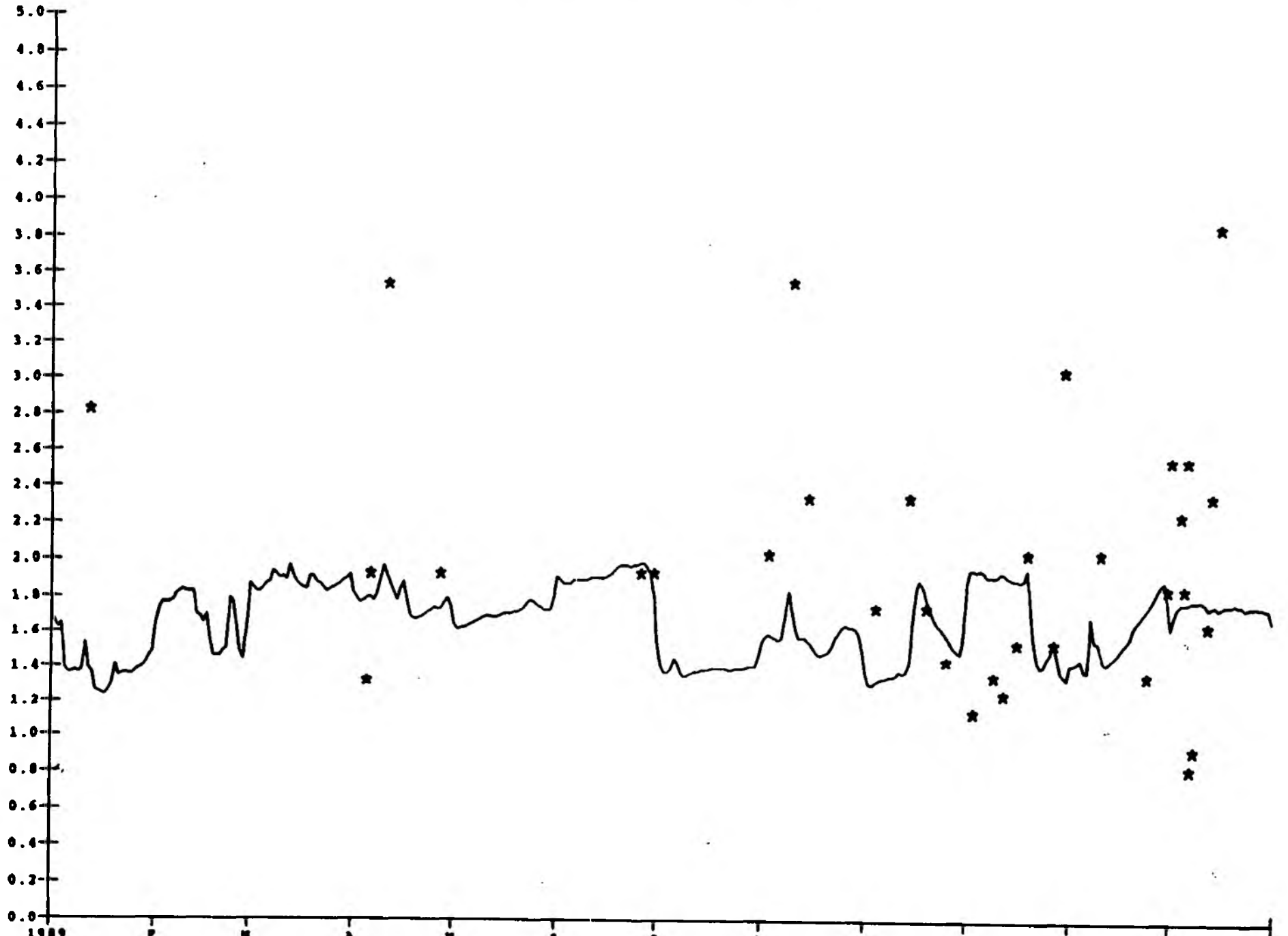
BOD at Exwick 1989



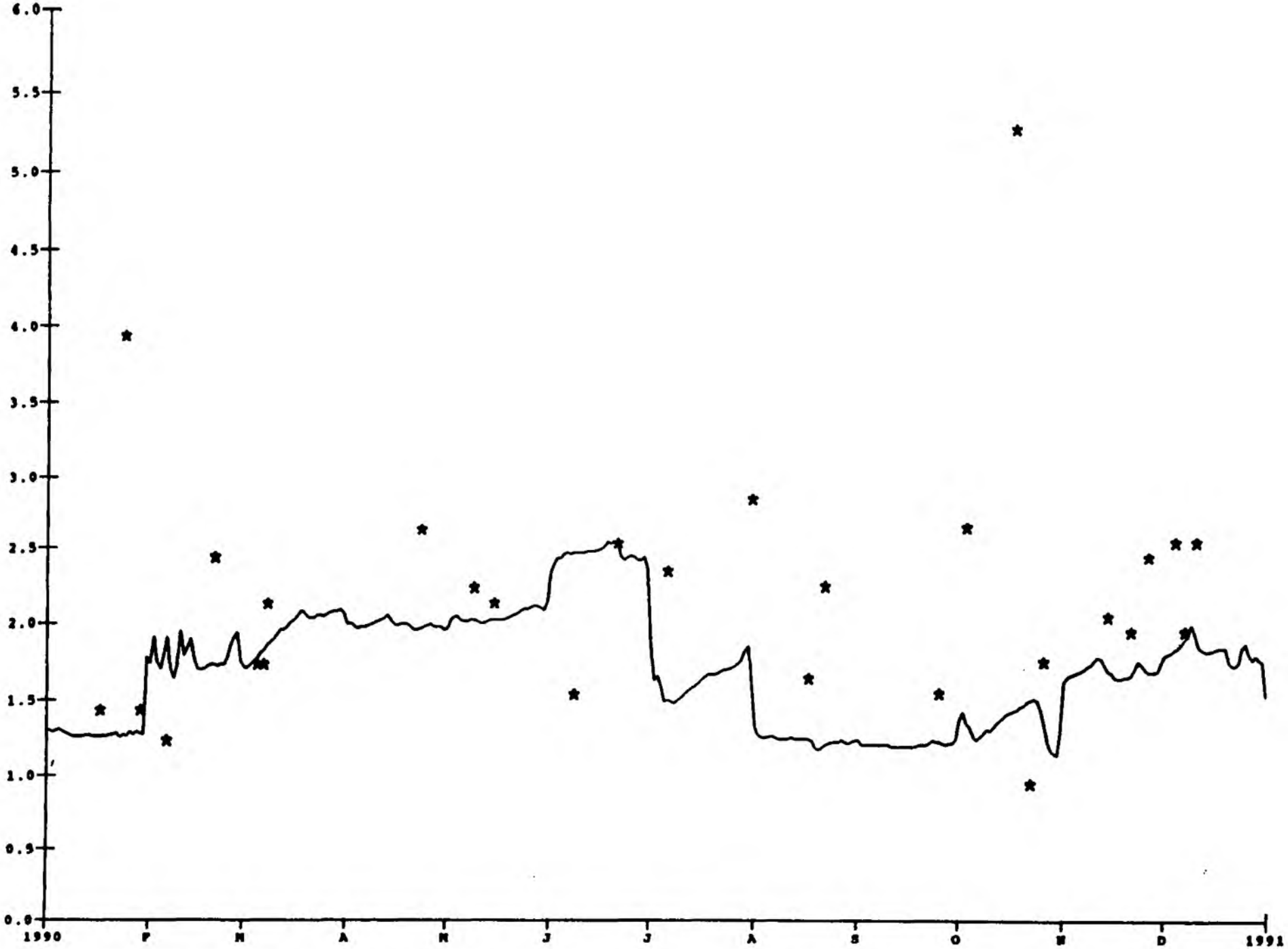
BOD at Exwick 1990



BOD at Trews Weir 1989



BOD at Trews Weir 1990



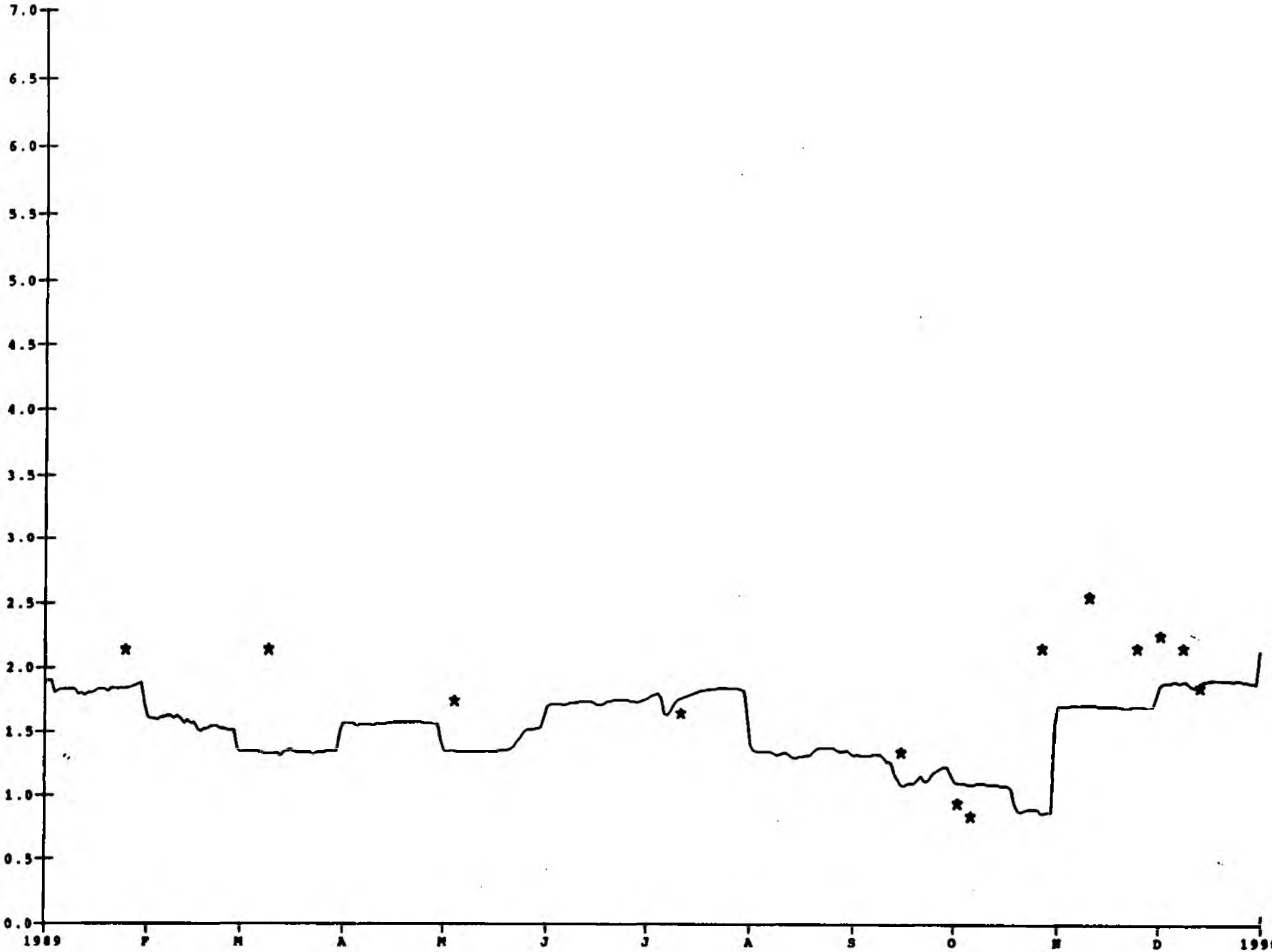
Appendix E - Nitrate Profiles

Contents:

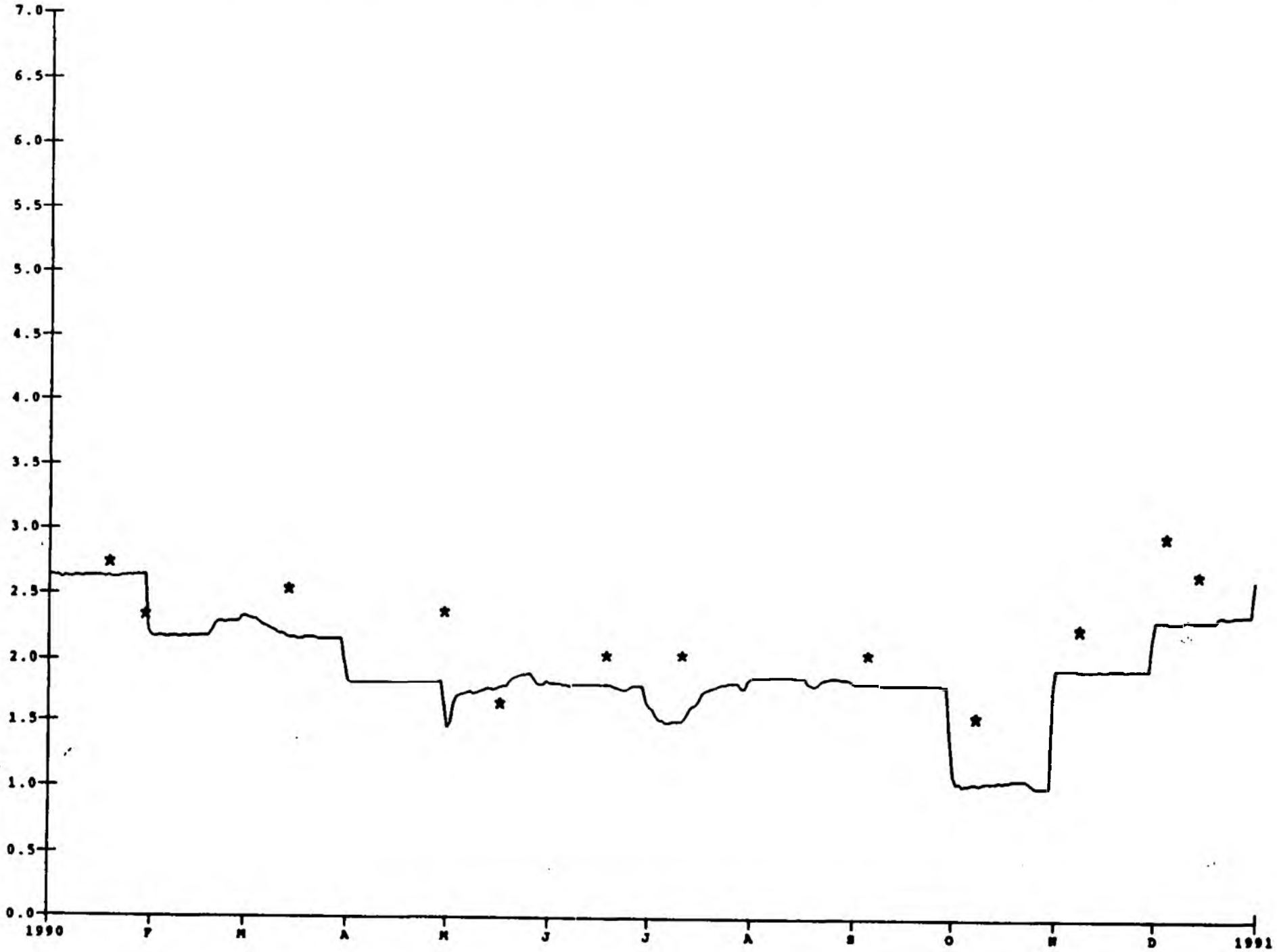
Annual Profiles for:

Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

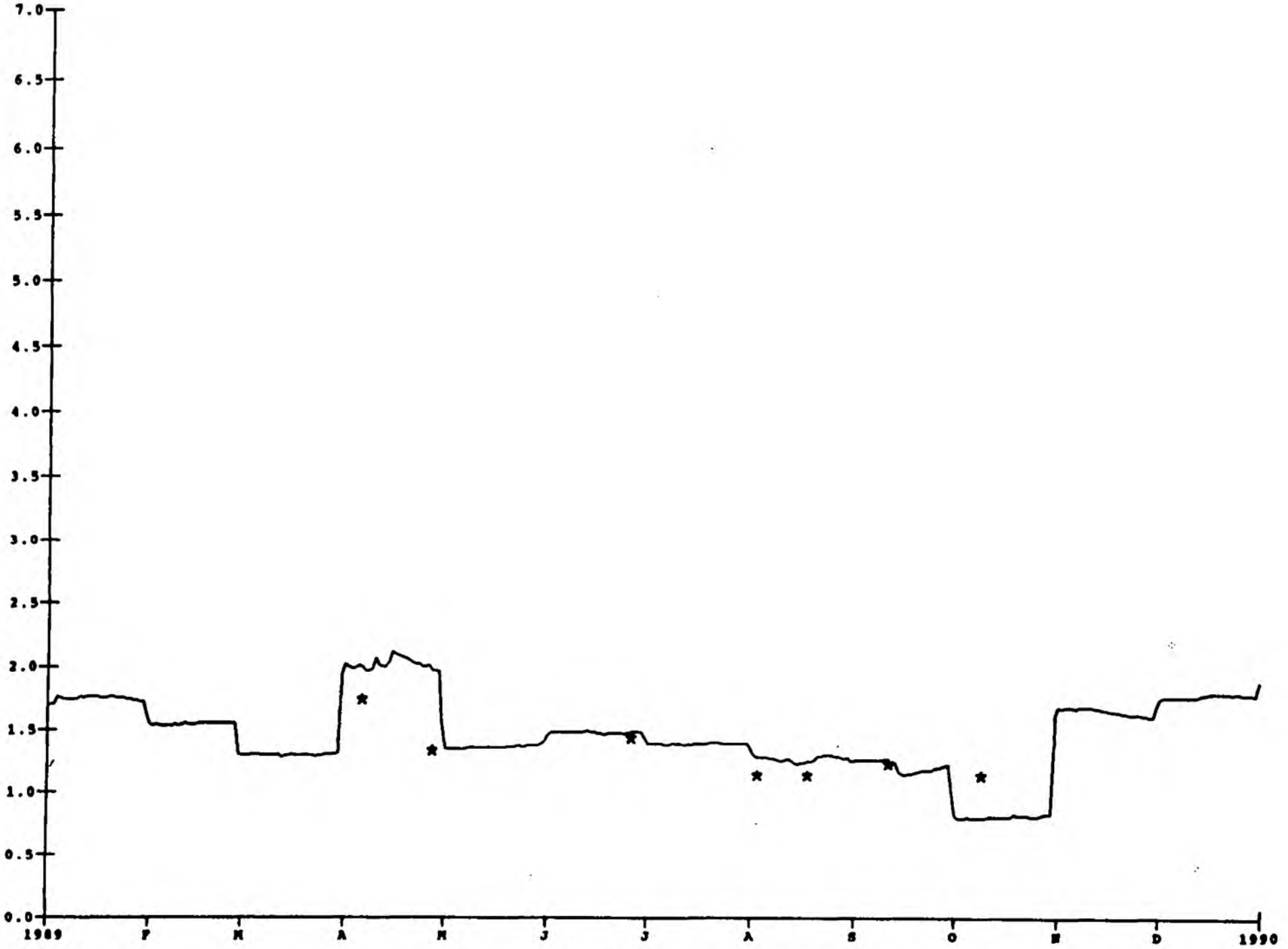
Nitrates at Pixton 1989



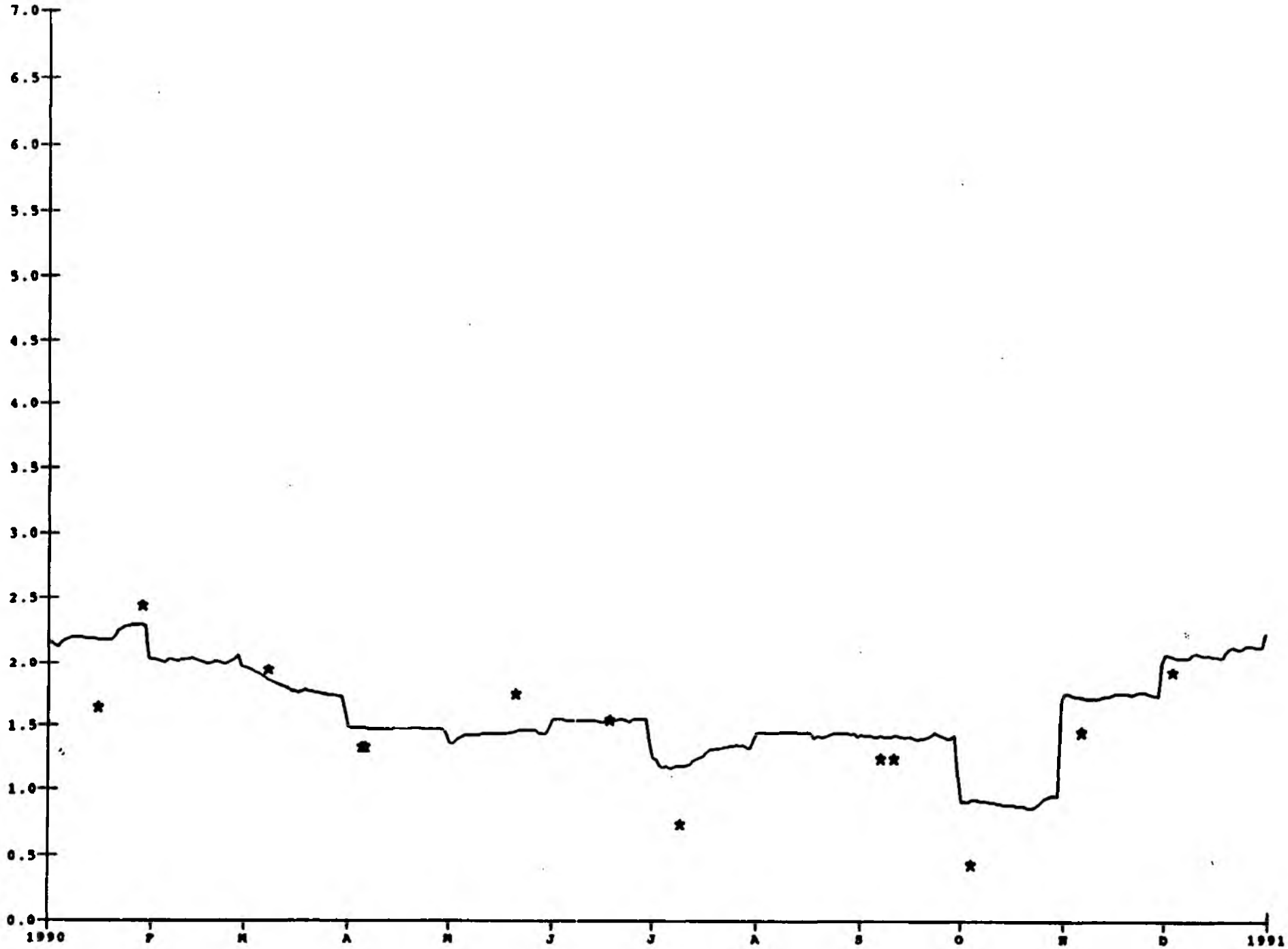
Nitrates at Pixton 1990



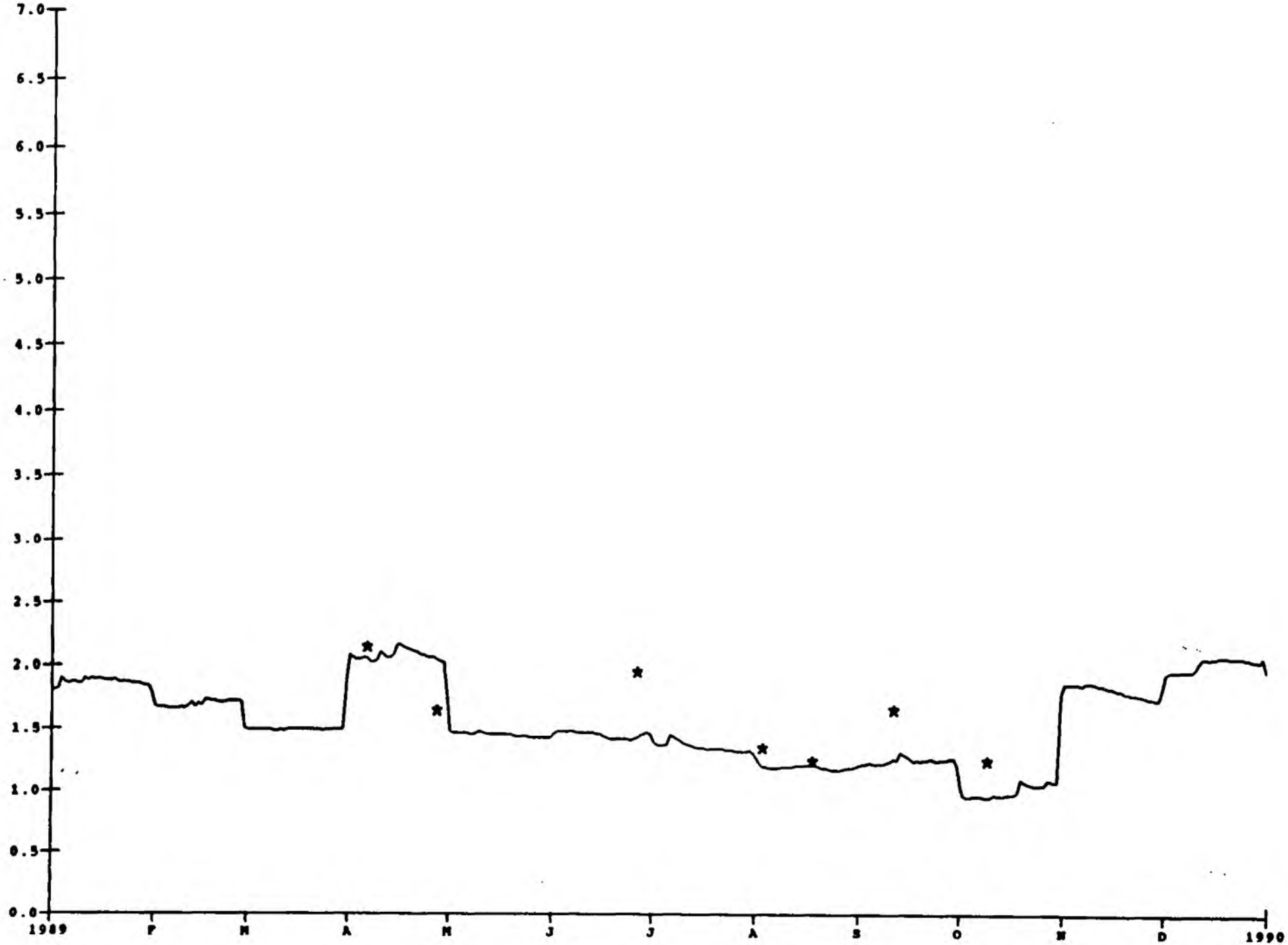
Nitrates at Halfpenny 1989



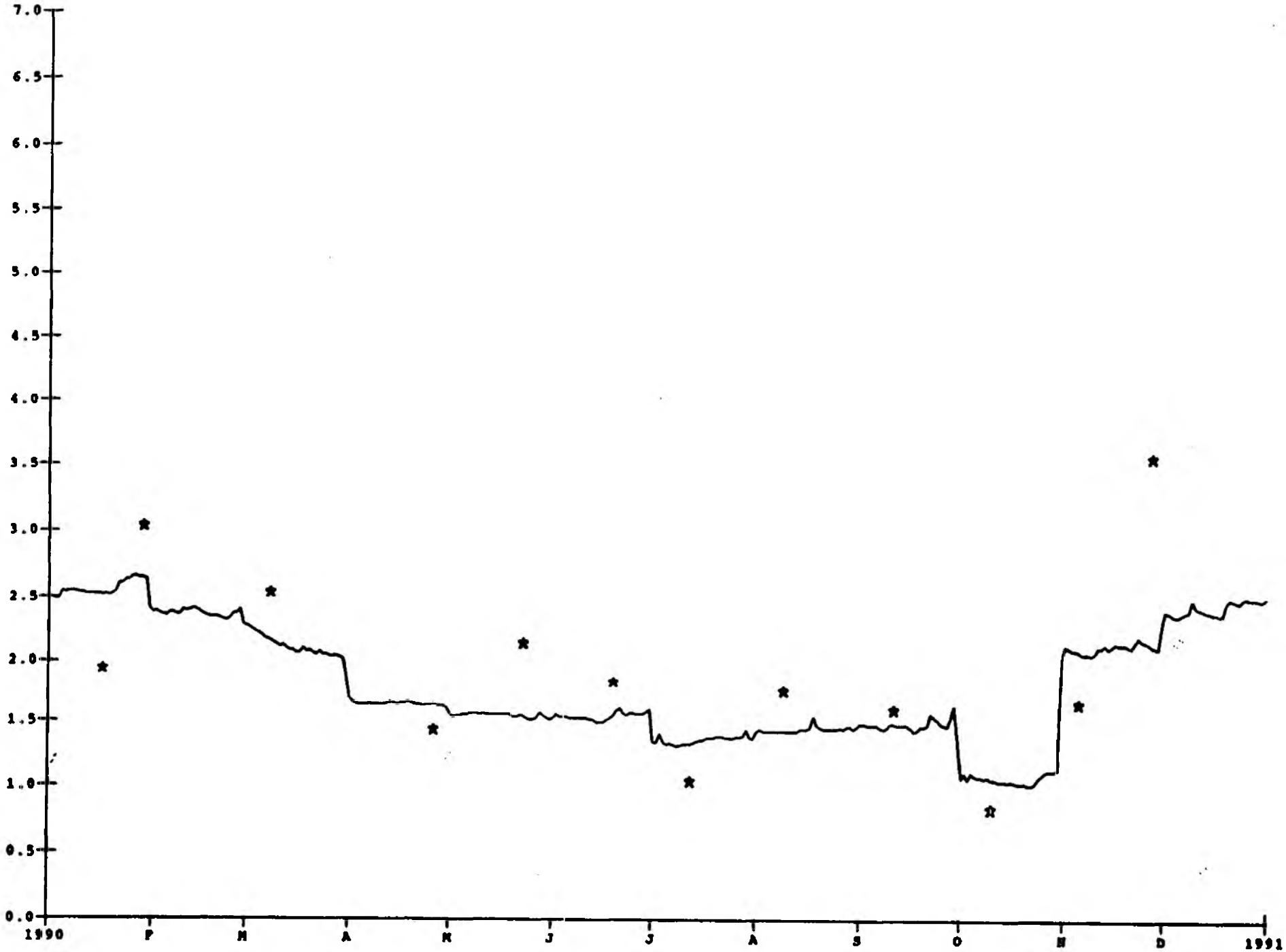
Nitrates at Halfpenny 1990



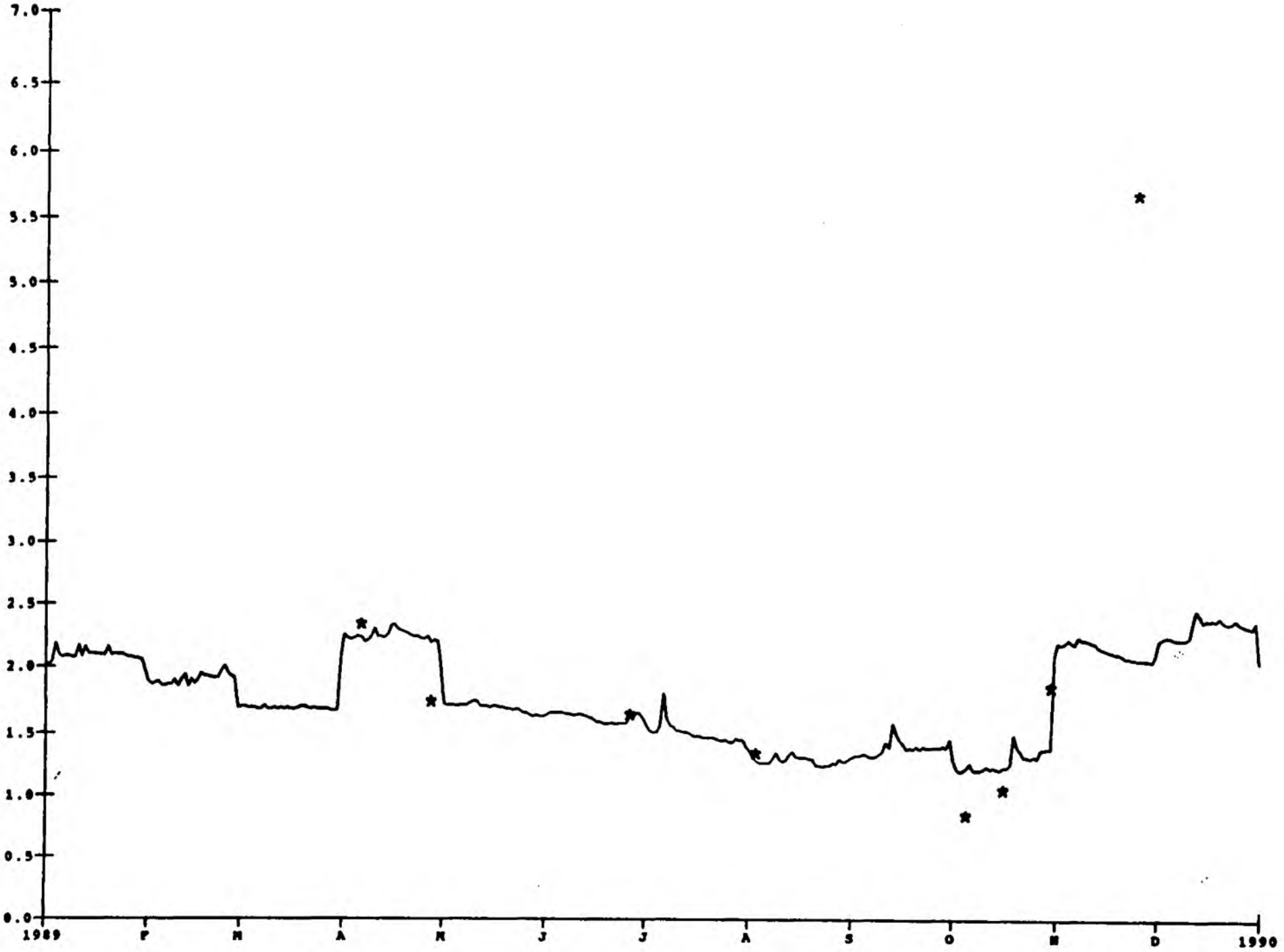
Nitrates at Tiverton 1989



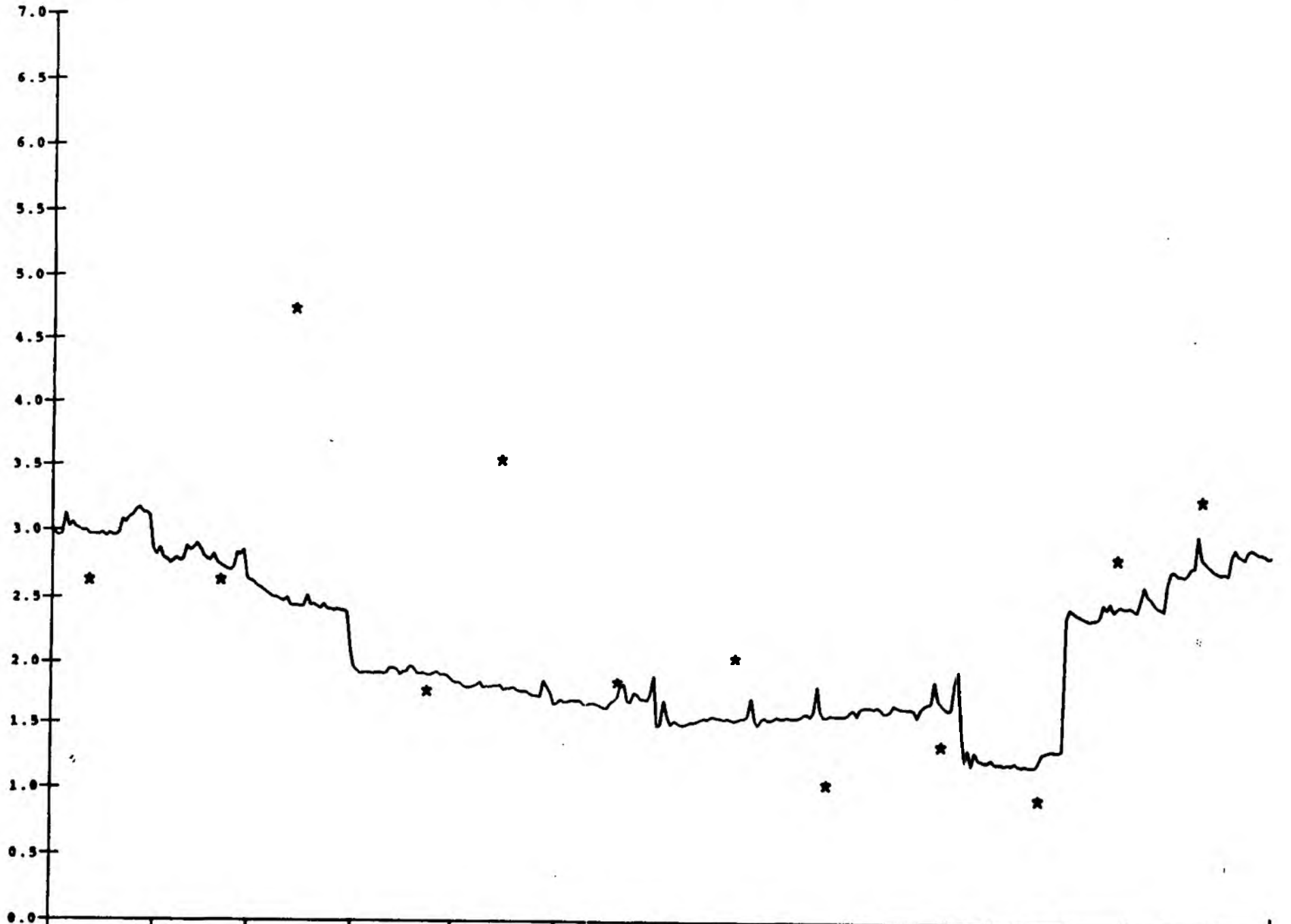
Nitrates at Tiverton 1990



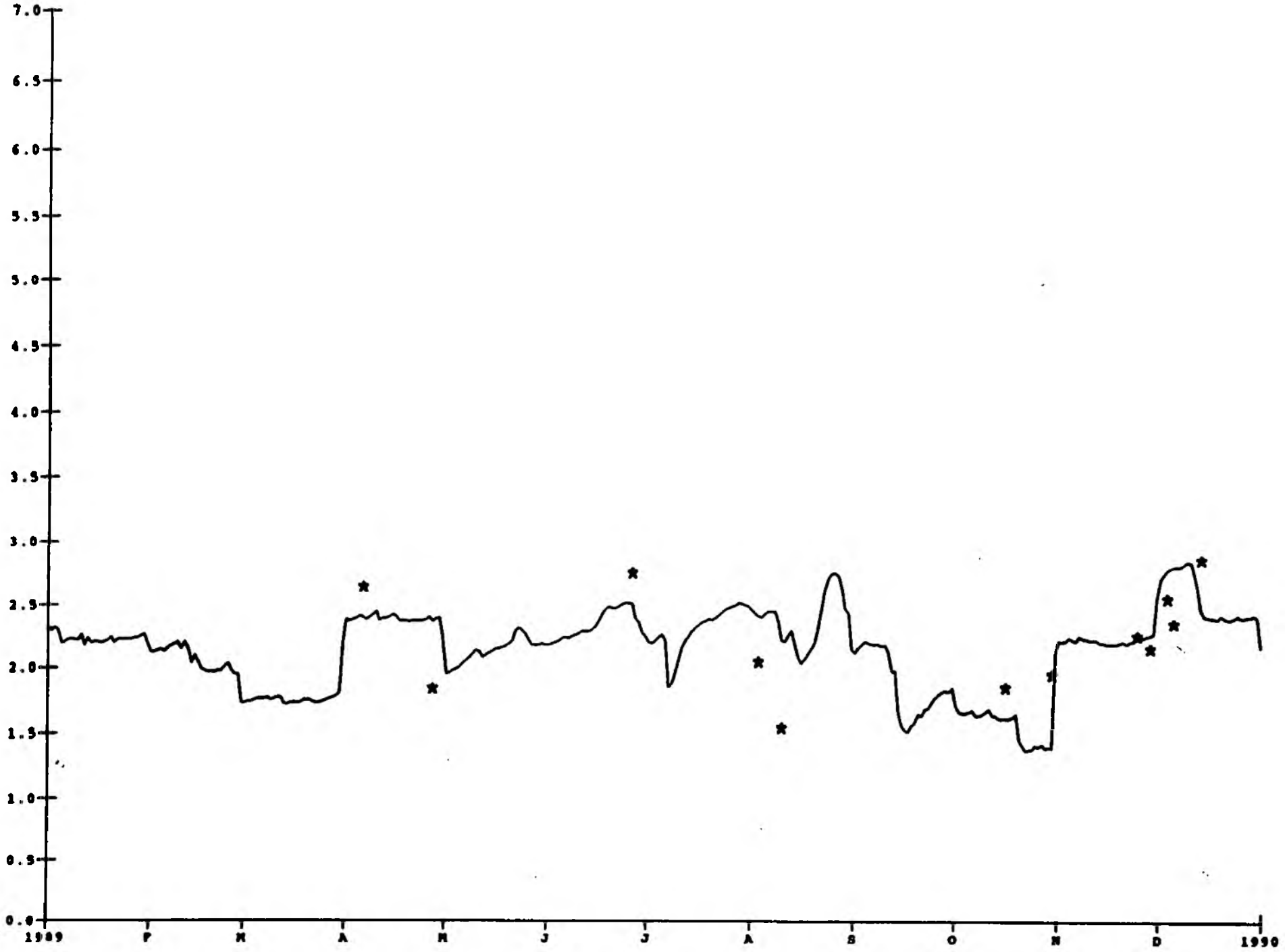
Nitrates at Colliprlest 1989



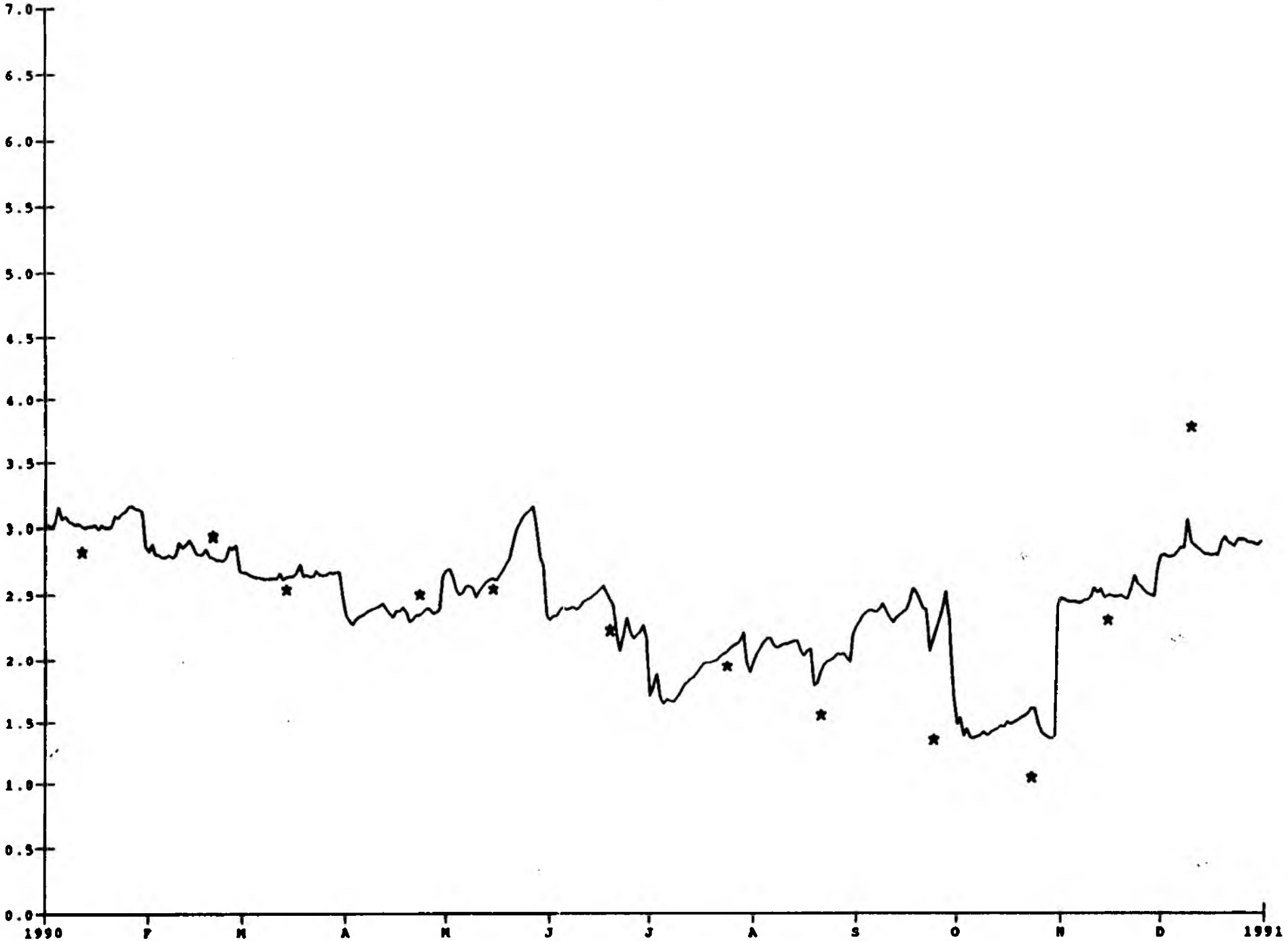
Nitrates at Colliprest 1990



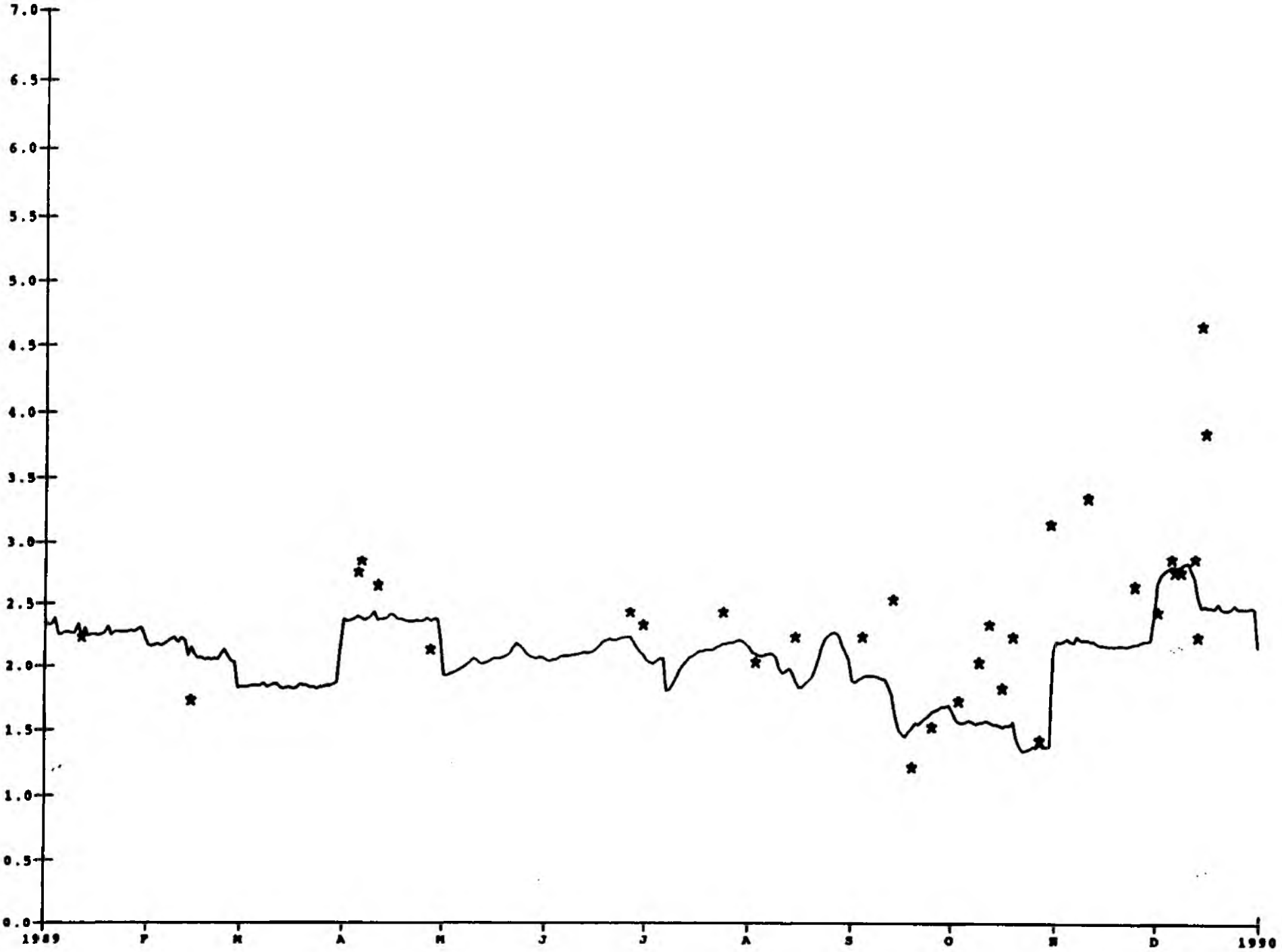
Nitrates at Ashley 1989

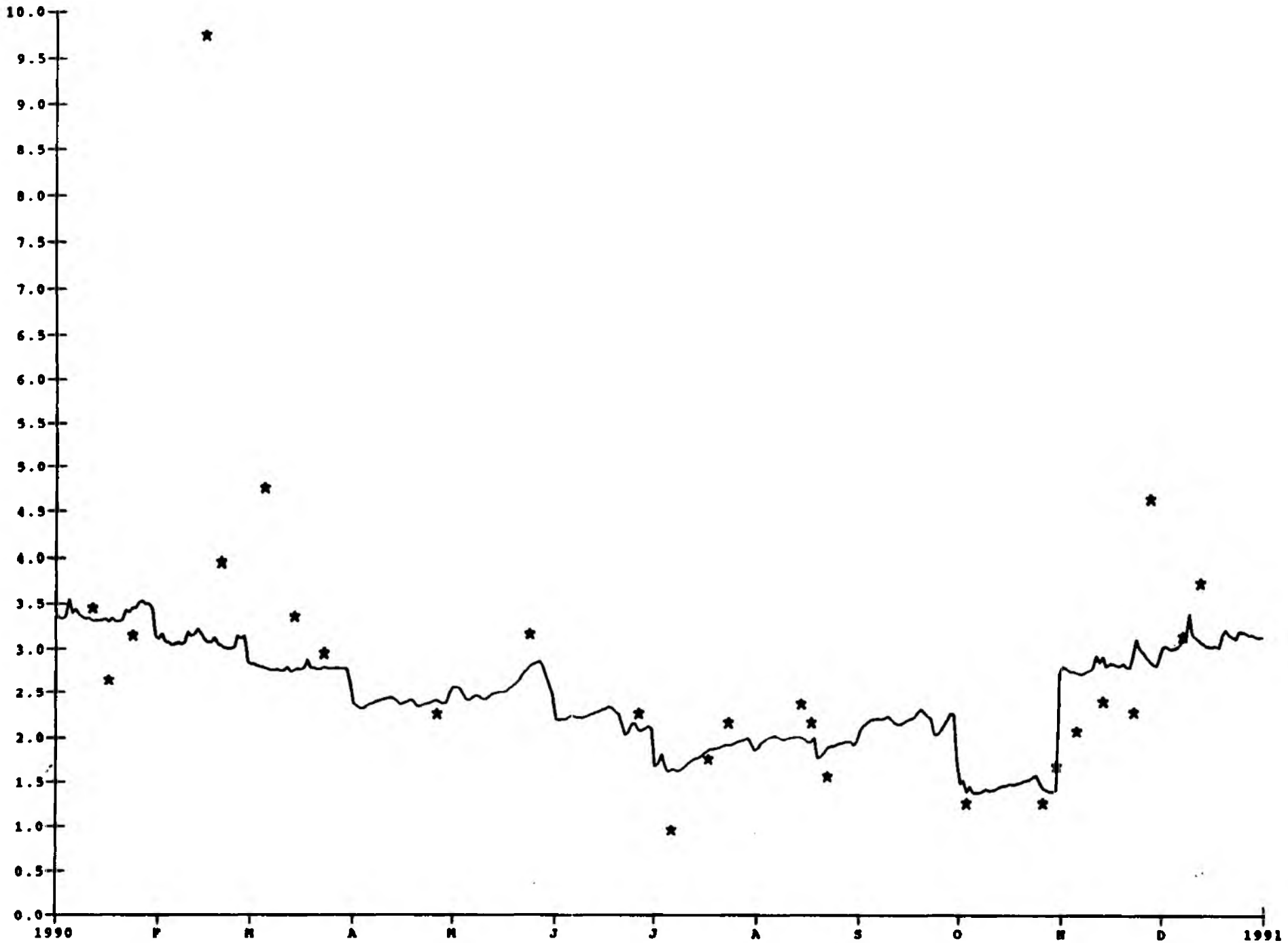


Nitrates at Ashley 1990



Nitrates at Thorveton 1989

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8.5
8.0
7.5
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6.5
6.0
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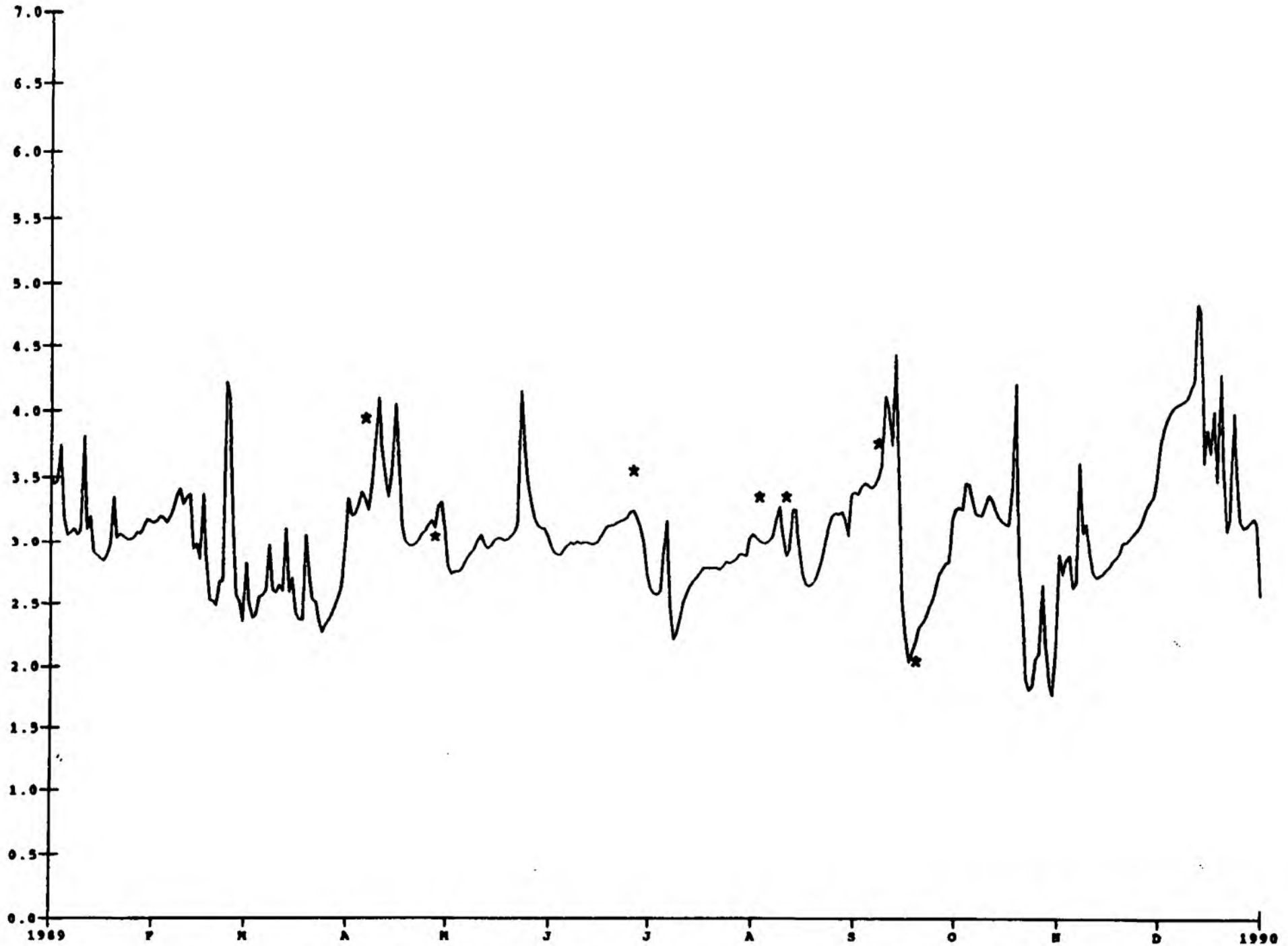
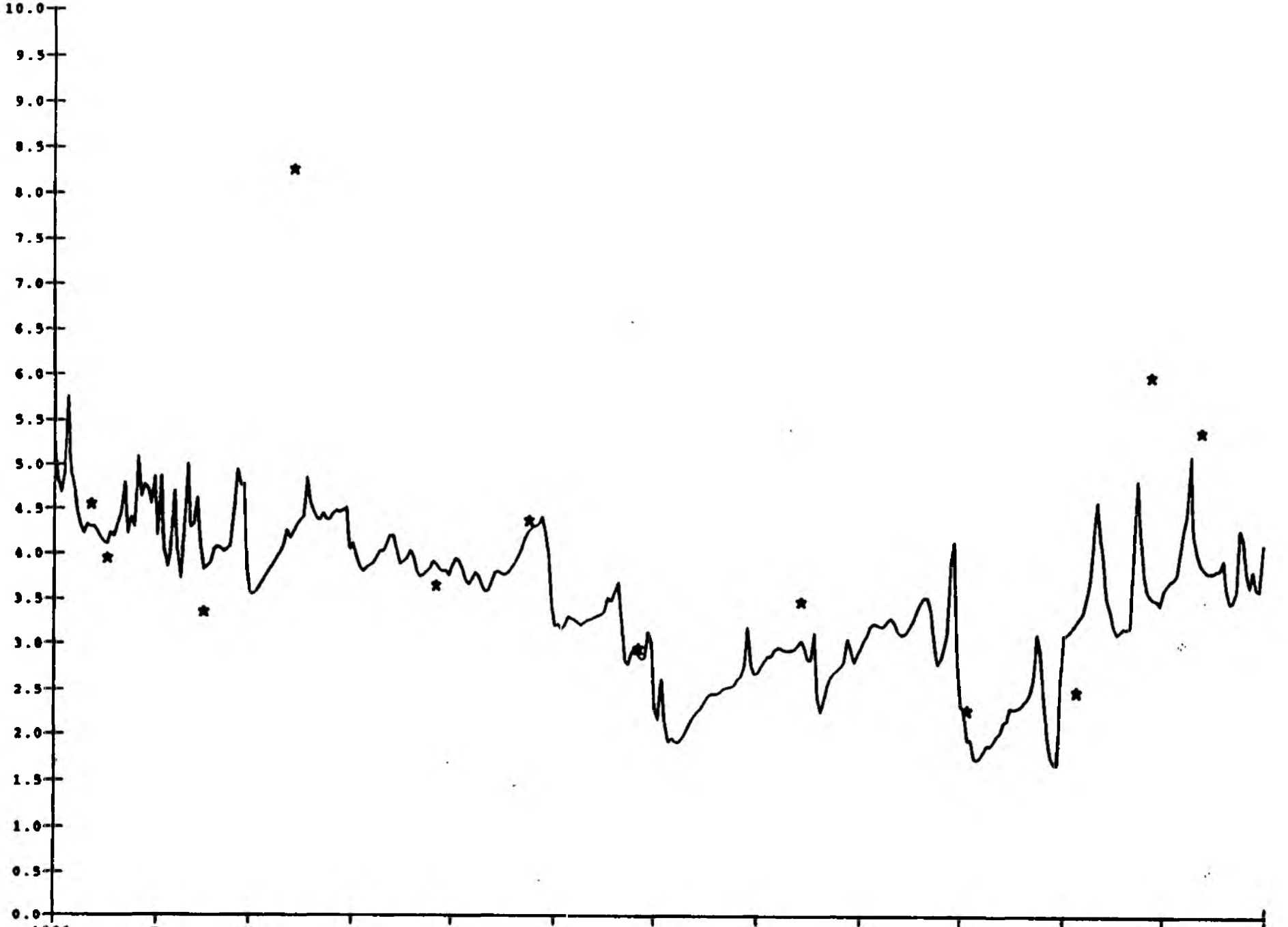
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
F
M
A
M
J
J
A
S
O
N
D
1991

Nitrates at Stafford Br. 1989

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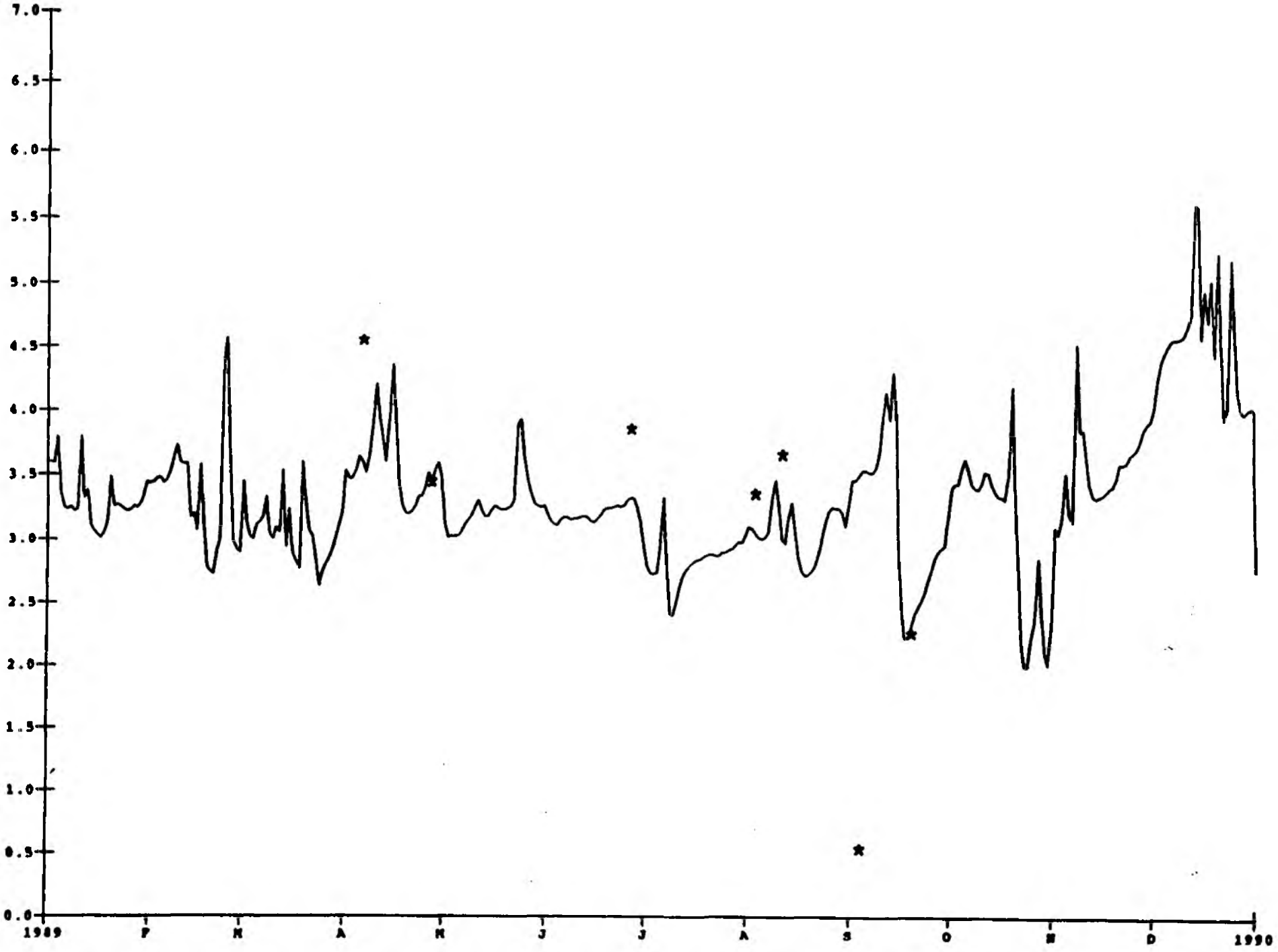
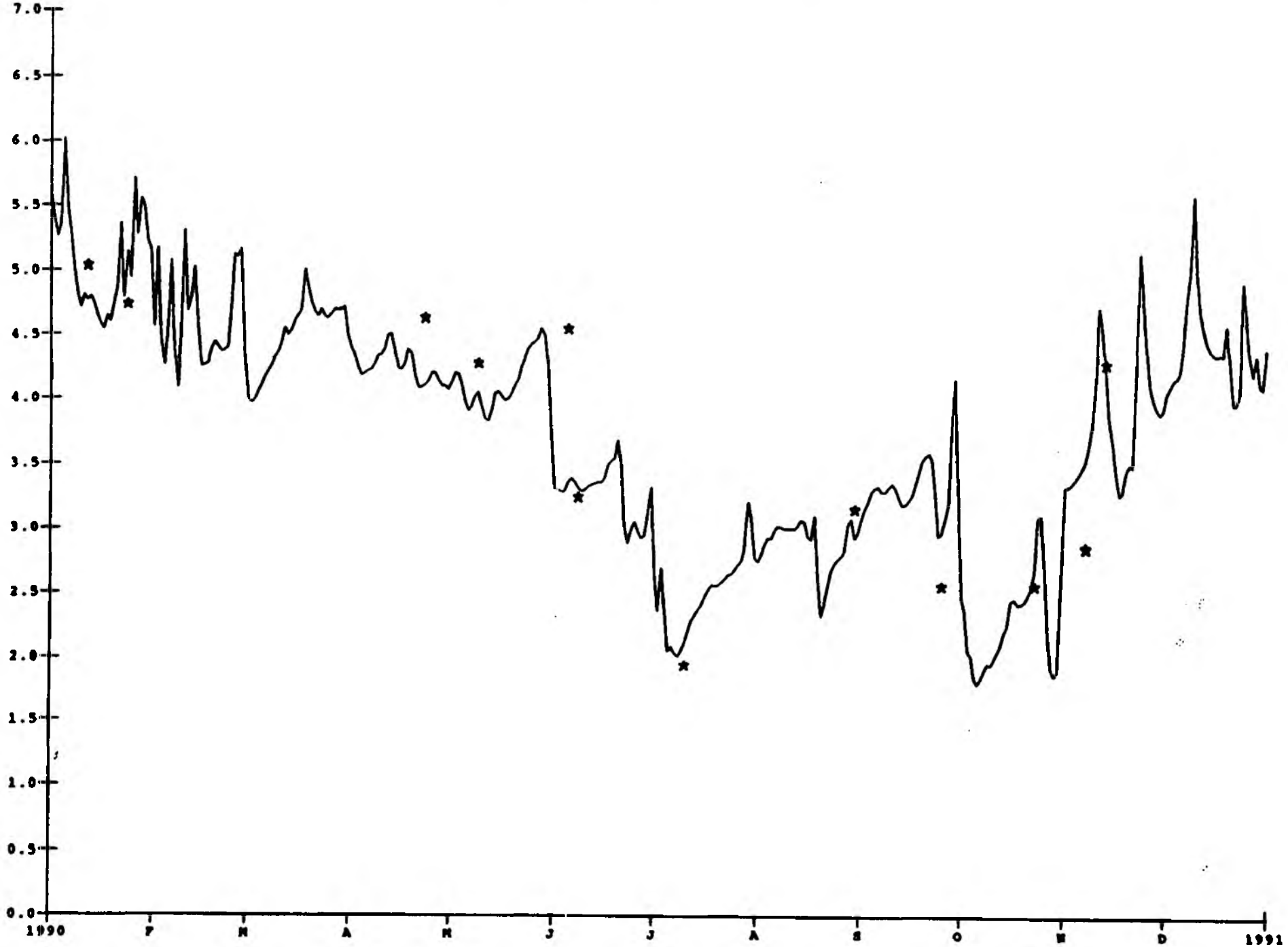
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
F
M
A
M
J
J
A
S
O
N
D
1991

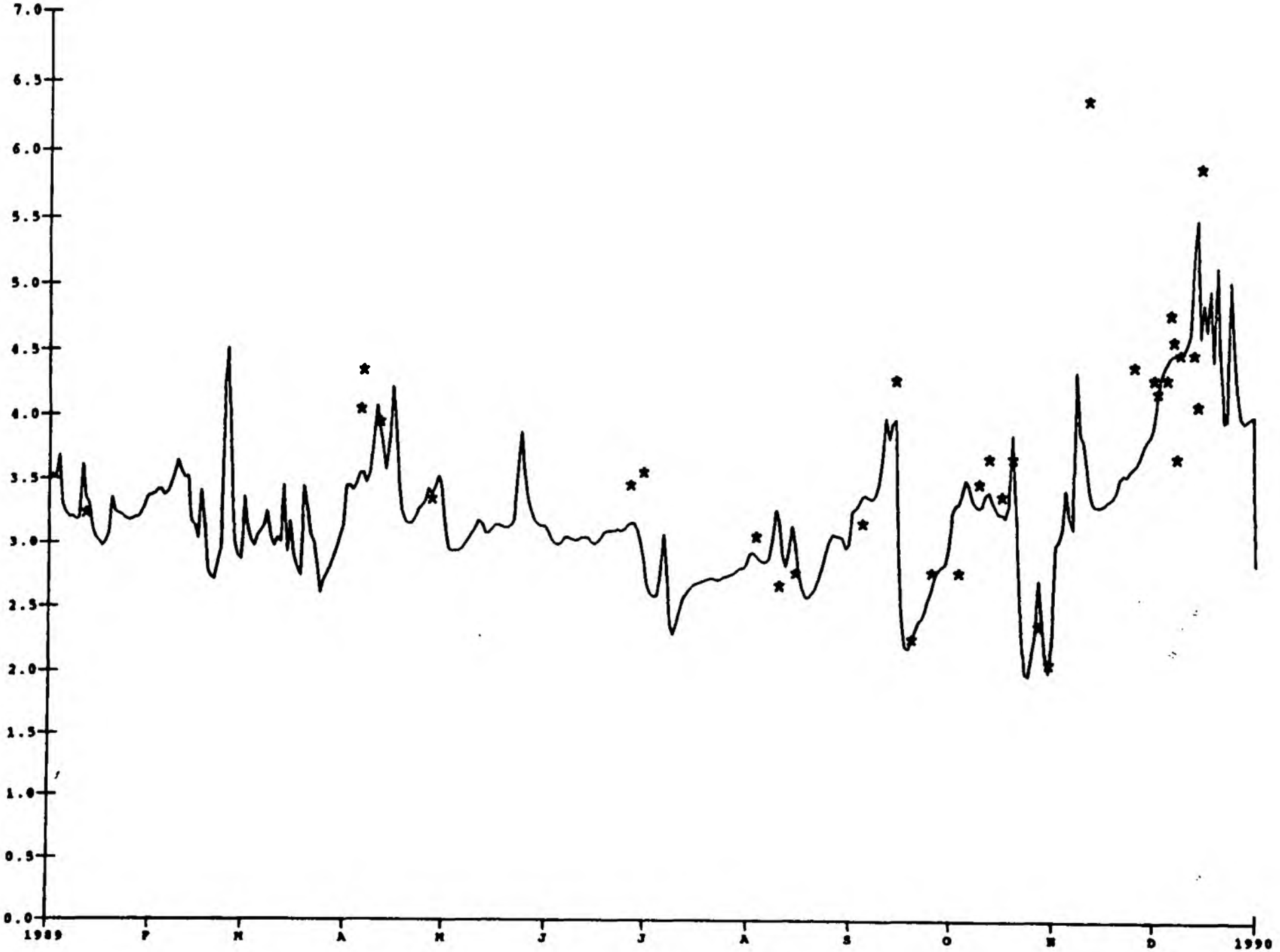
Nitrates at Exwick 1989



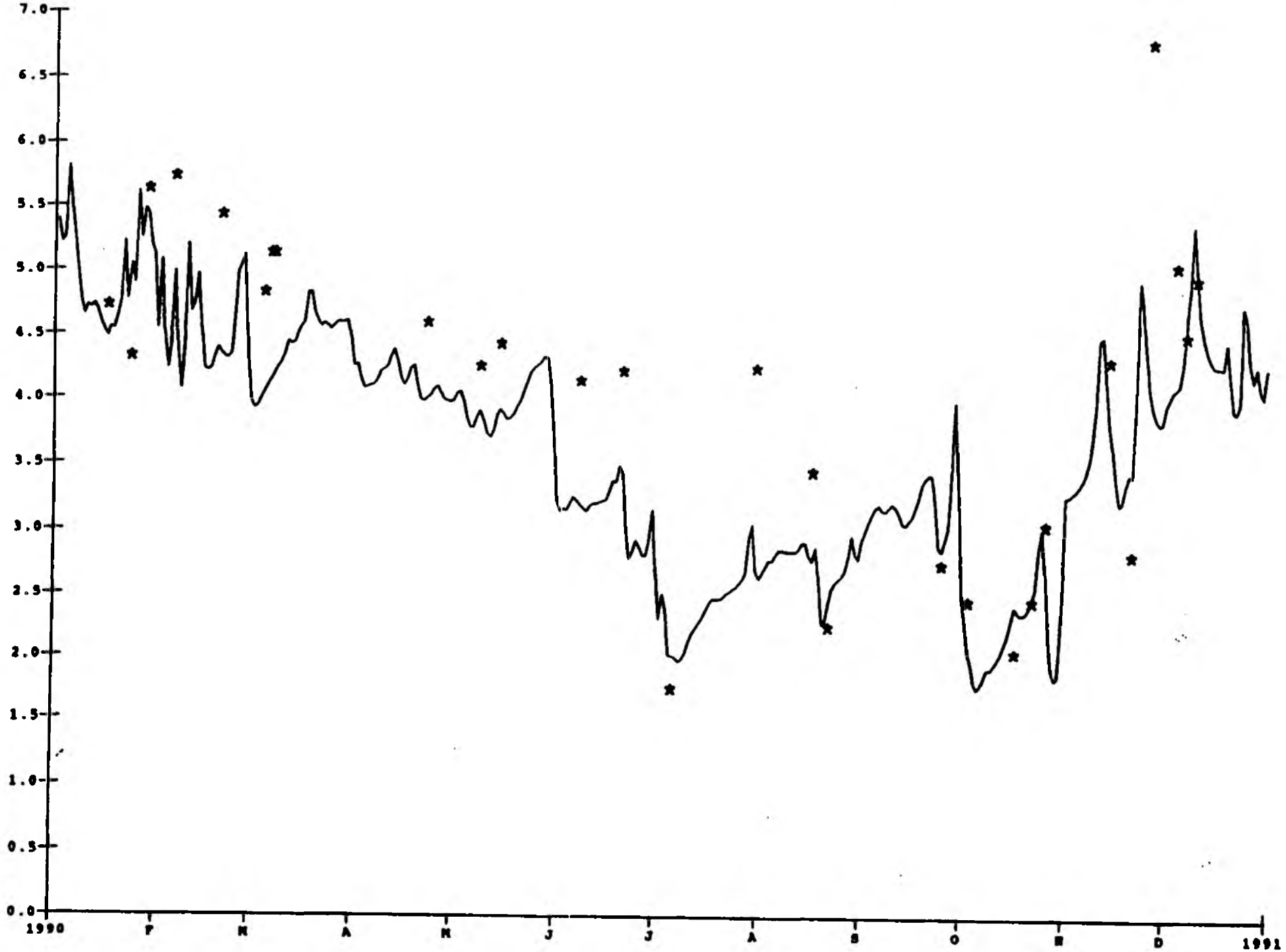
Nitrates at Exwick 1990



Nitrates at Trews Weir 1989



Nitrates at Trews Weir 1990



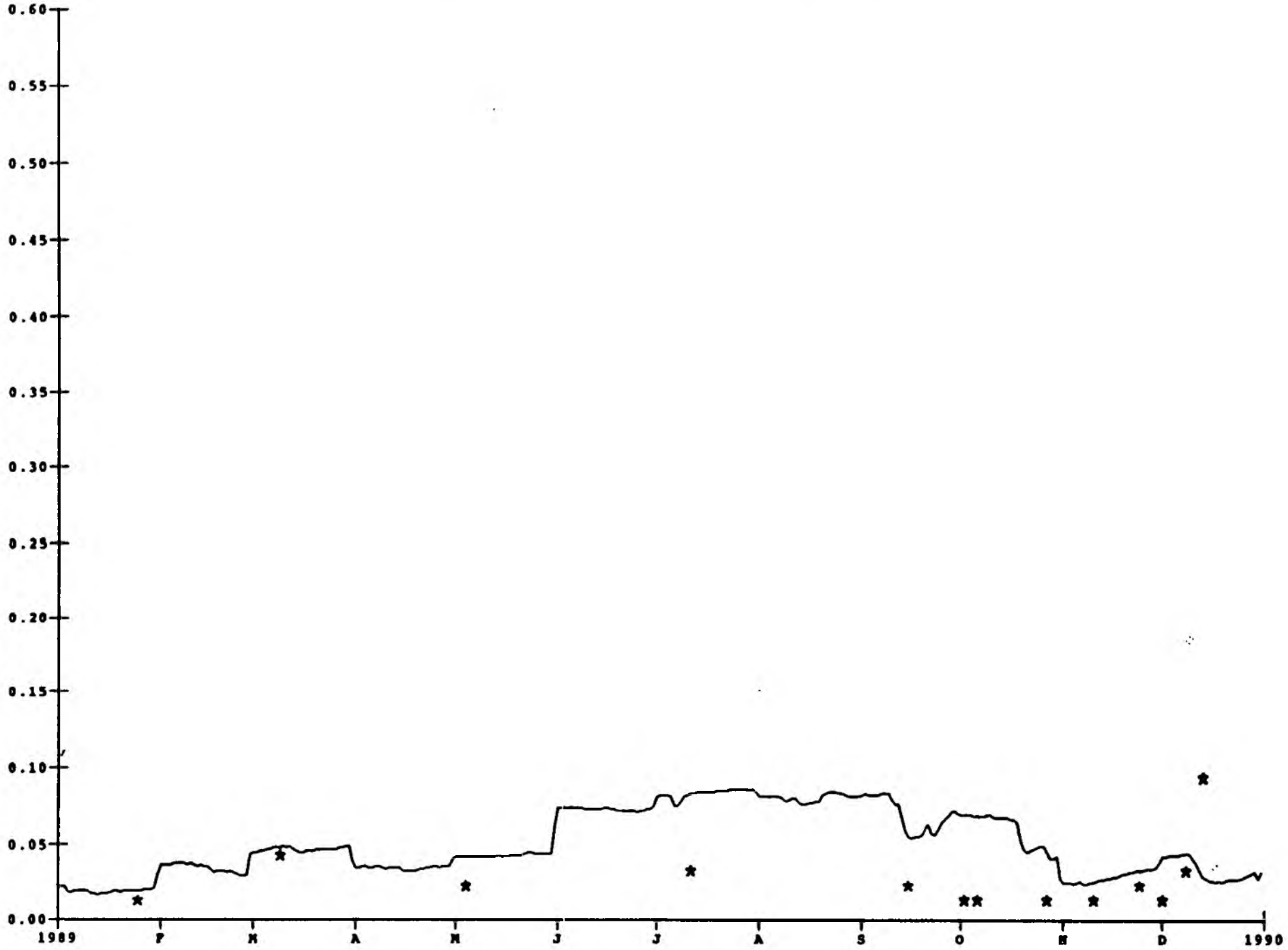
Appendix F – Ammonia Profiles

Contents:

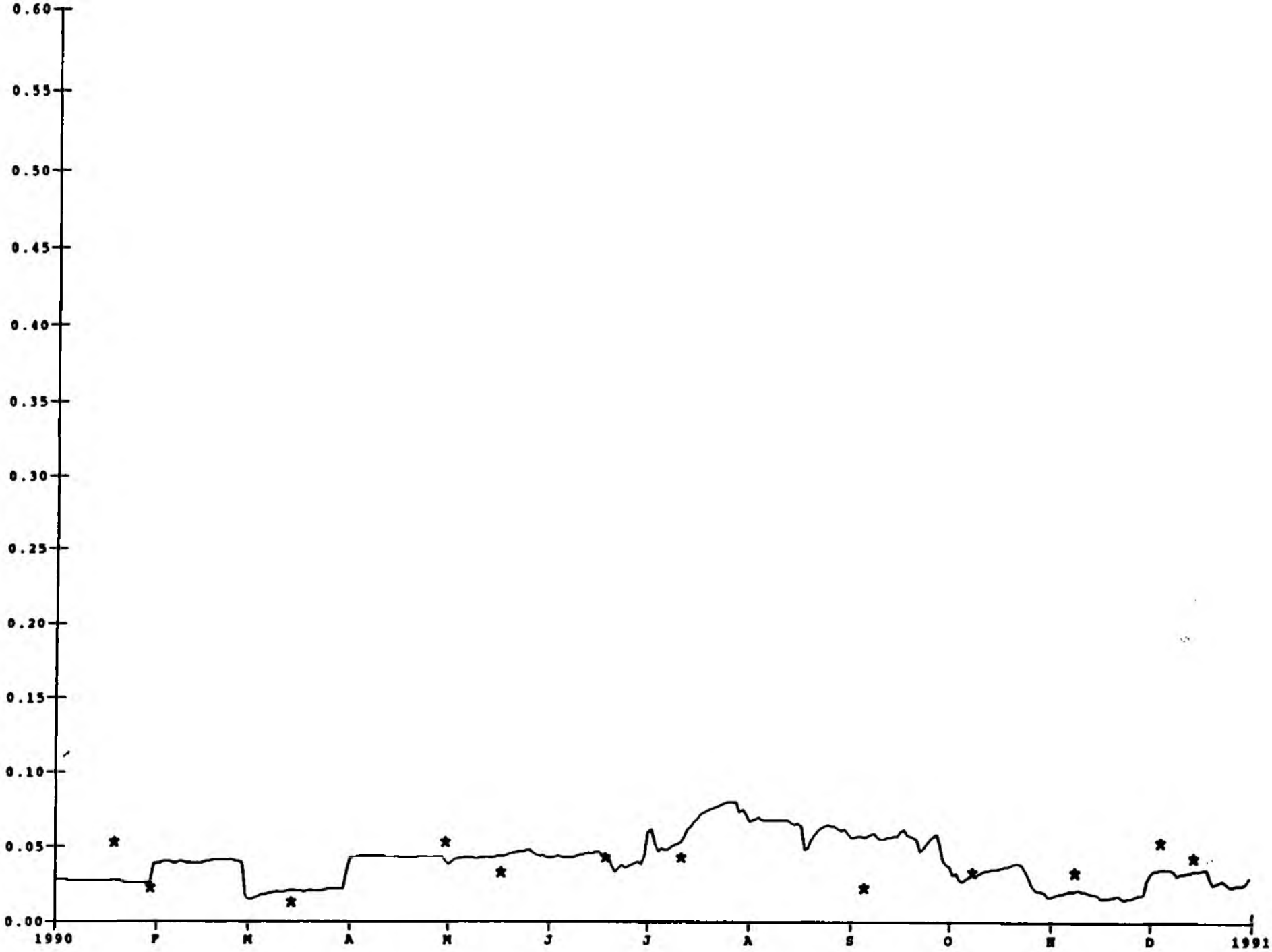
Annual Profiles for:

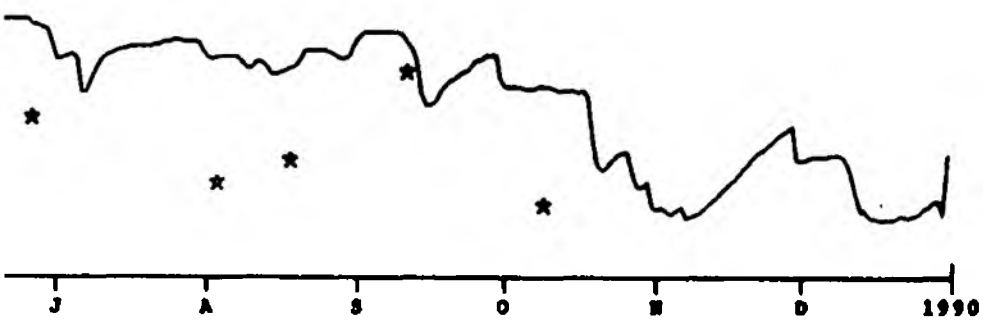
Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

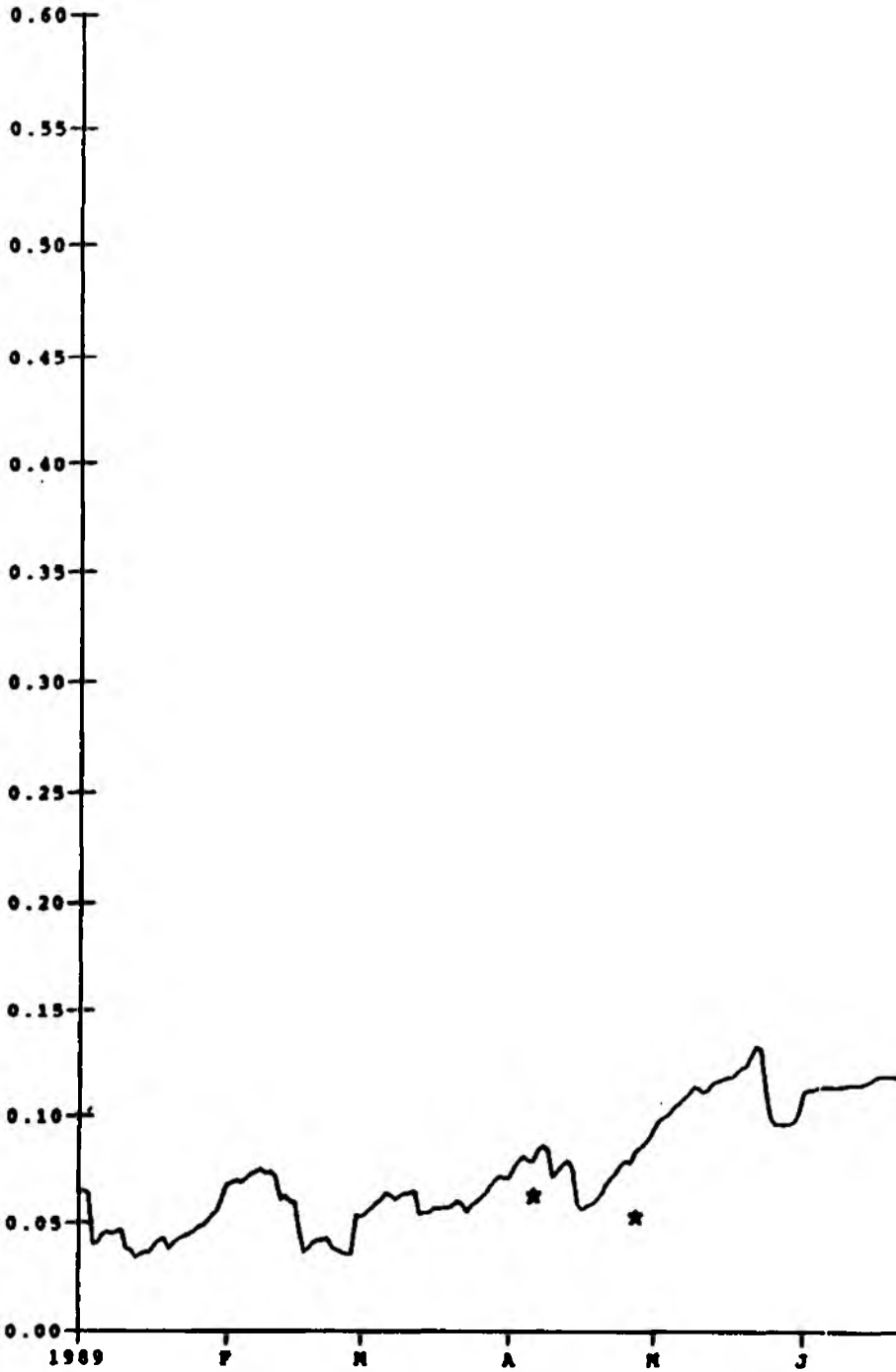
Ammonia at Pixton 1989



Ammonia at Pixton 1990




J
A
S
O
N
D
1990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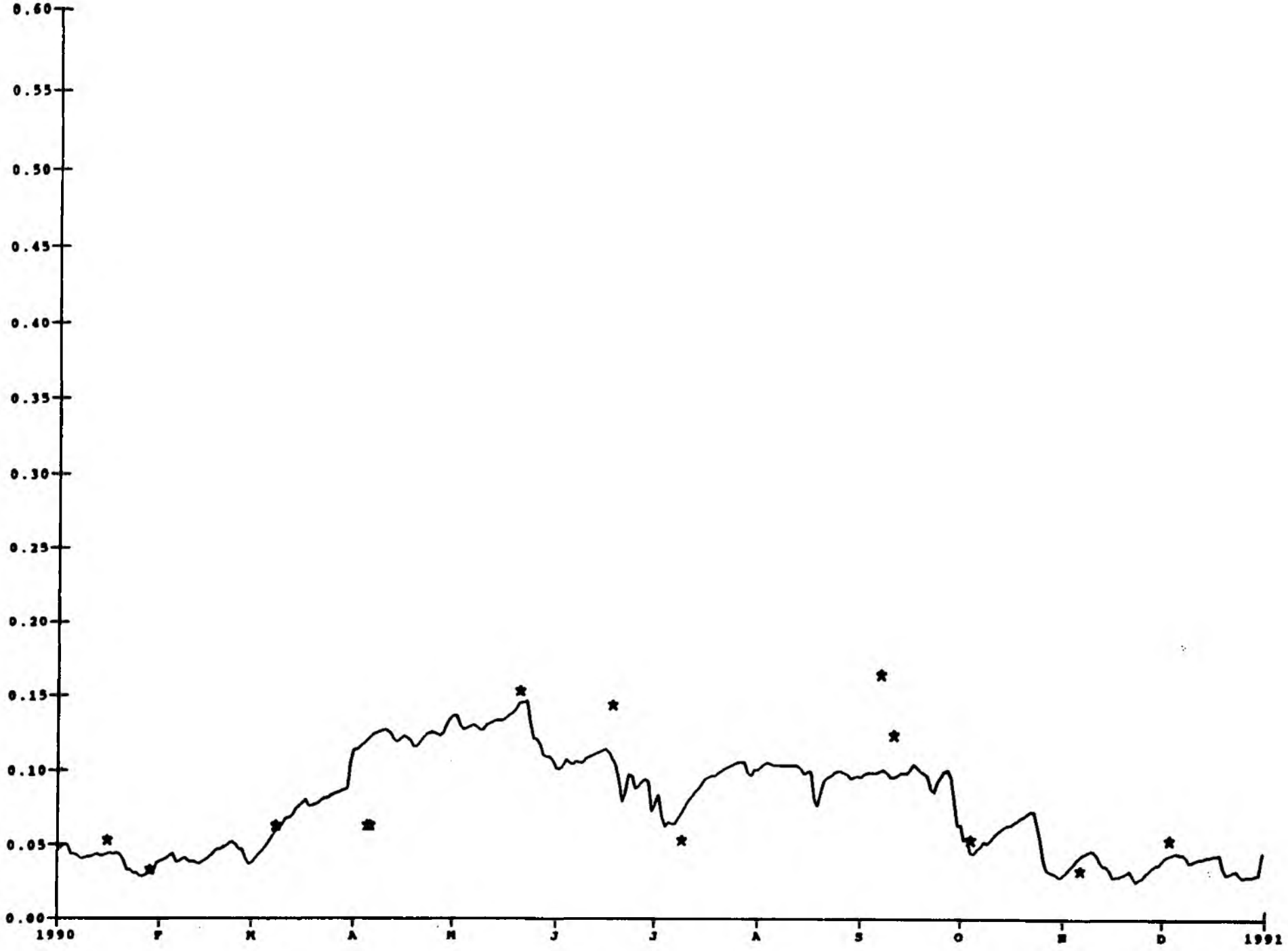
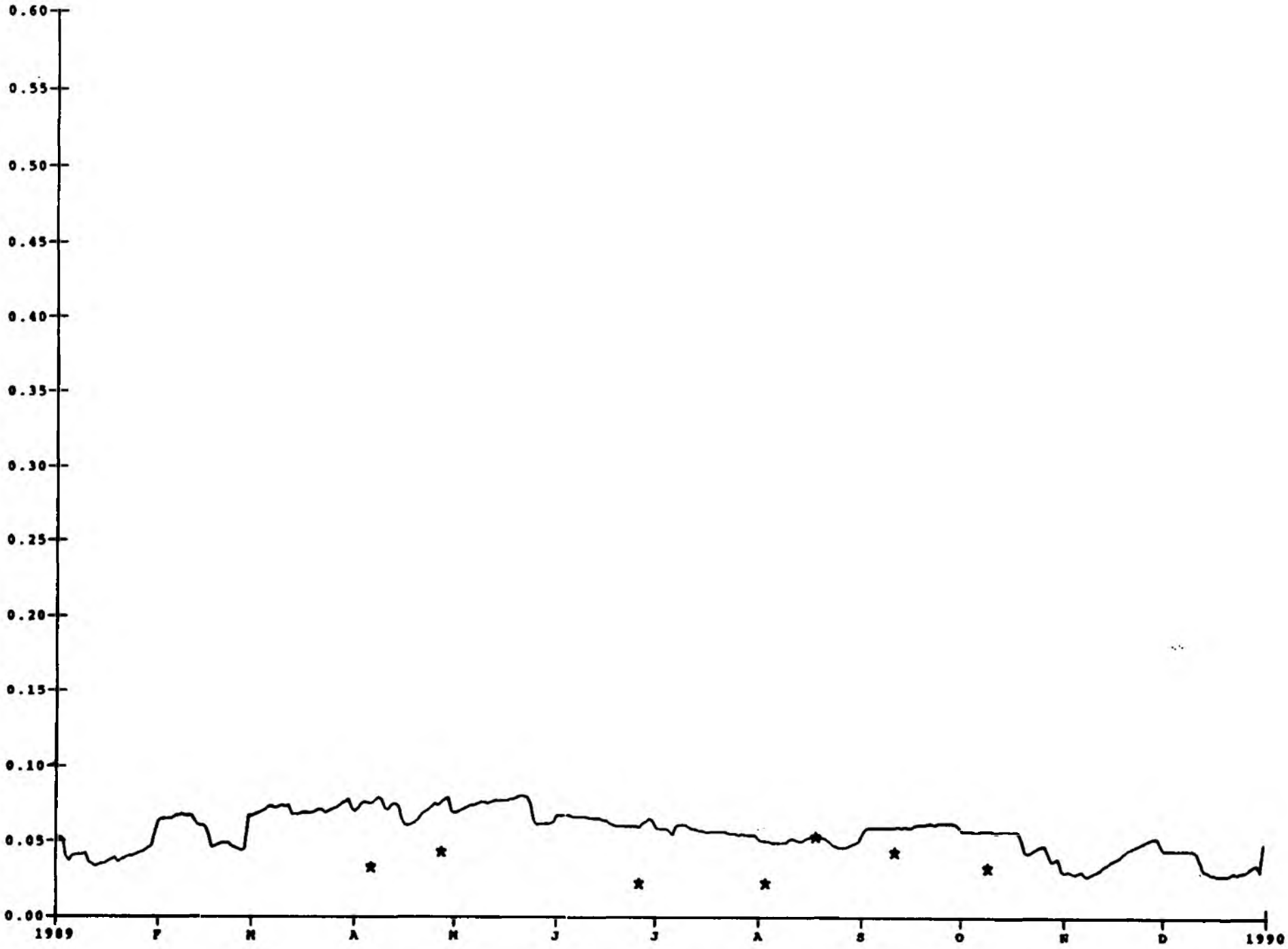
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1989
F
M
A
M
J

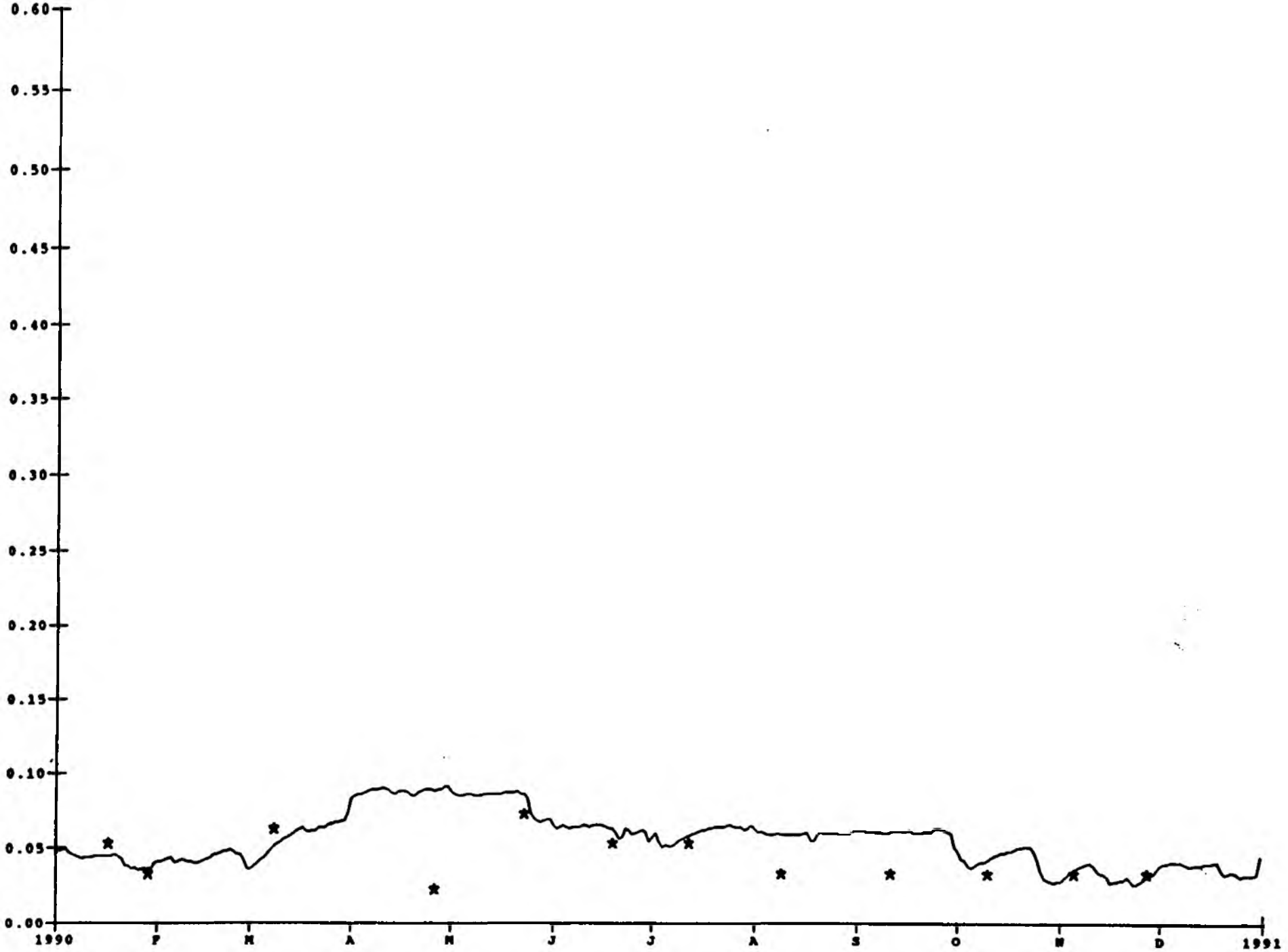
Ammonia at Halfpenny 1990



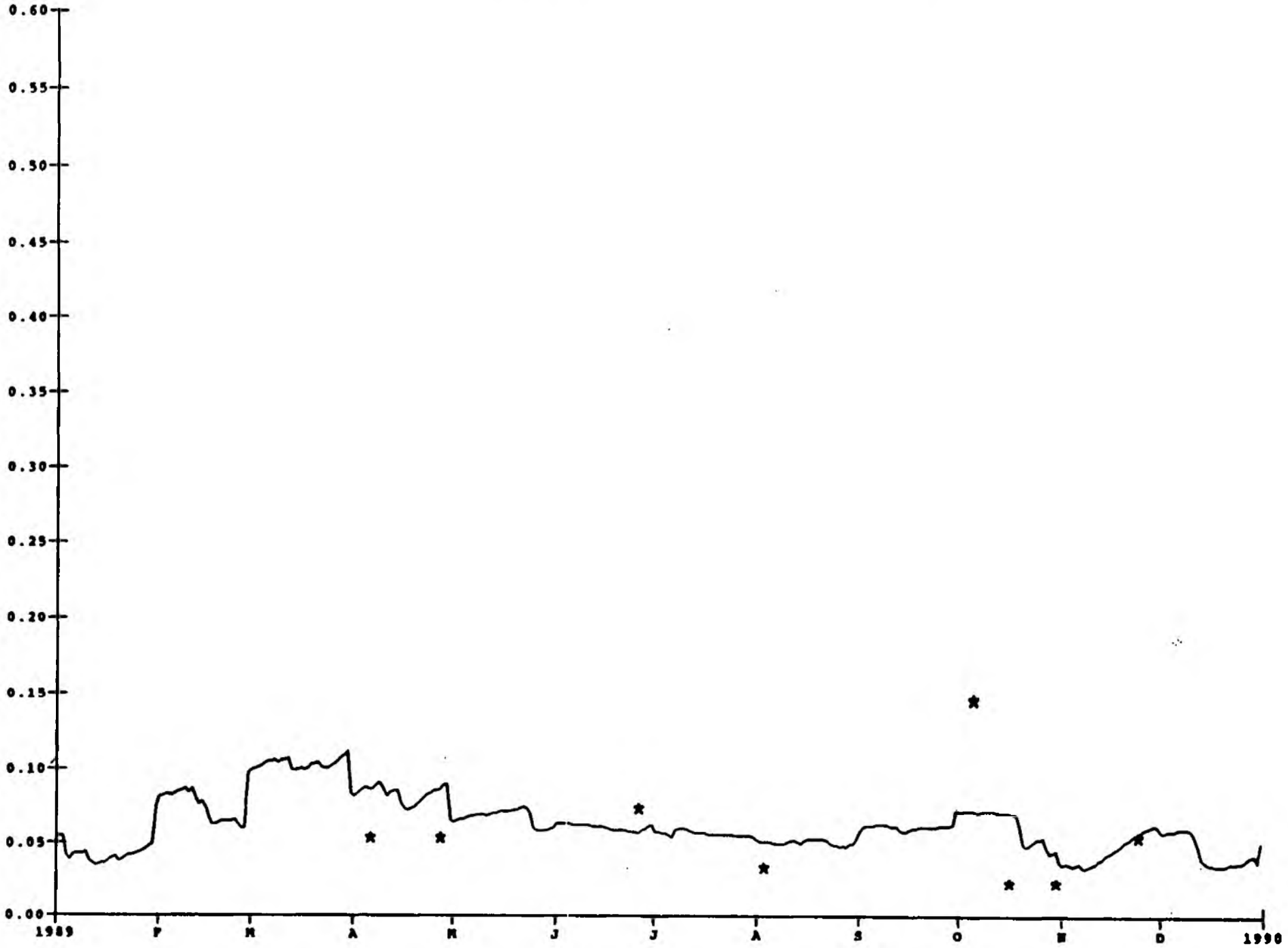
Ammonia at Tiverton 1989



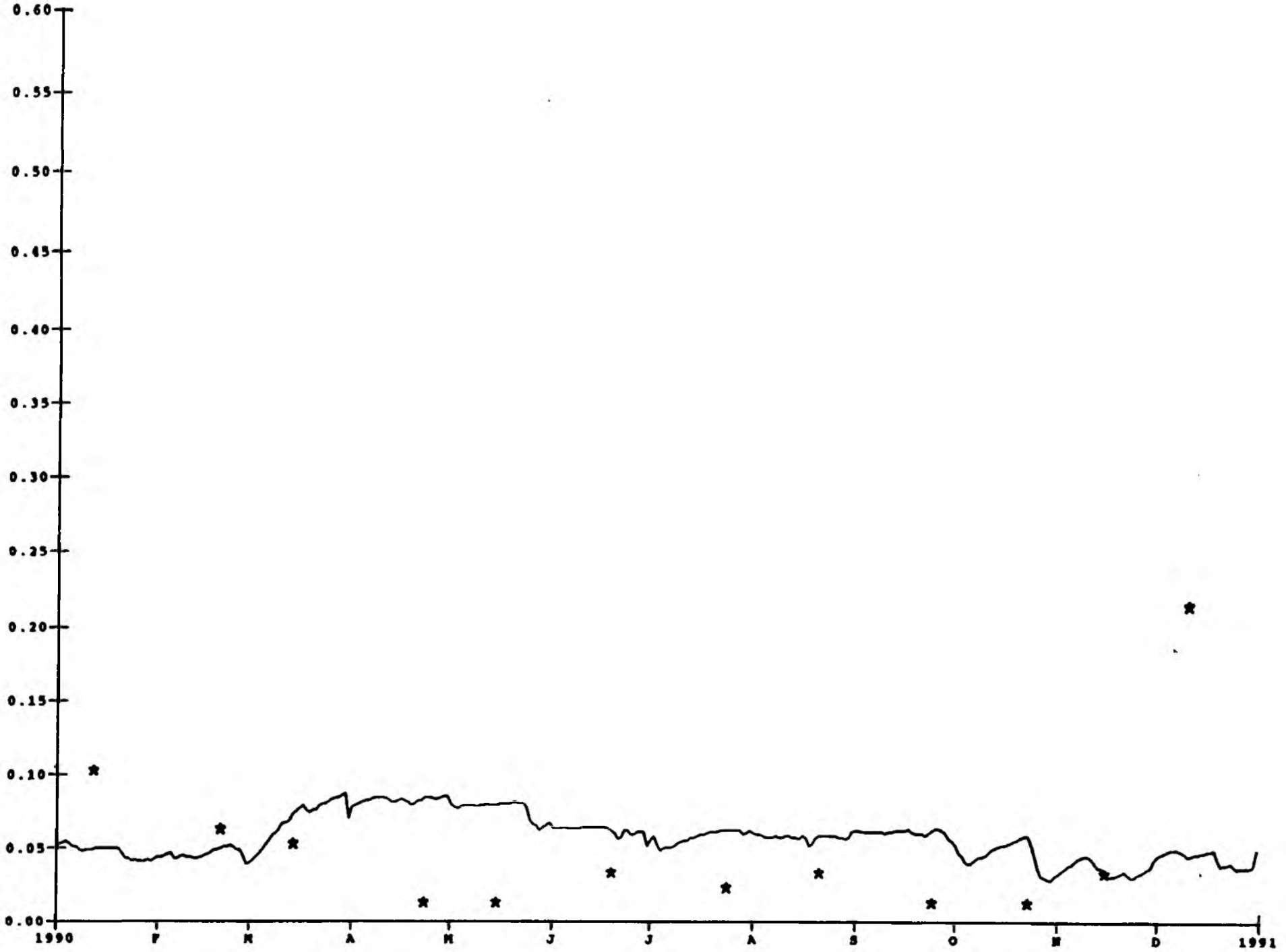
Ammonia at Tiverton 1990



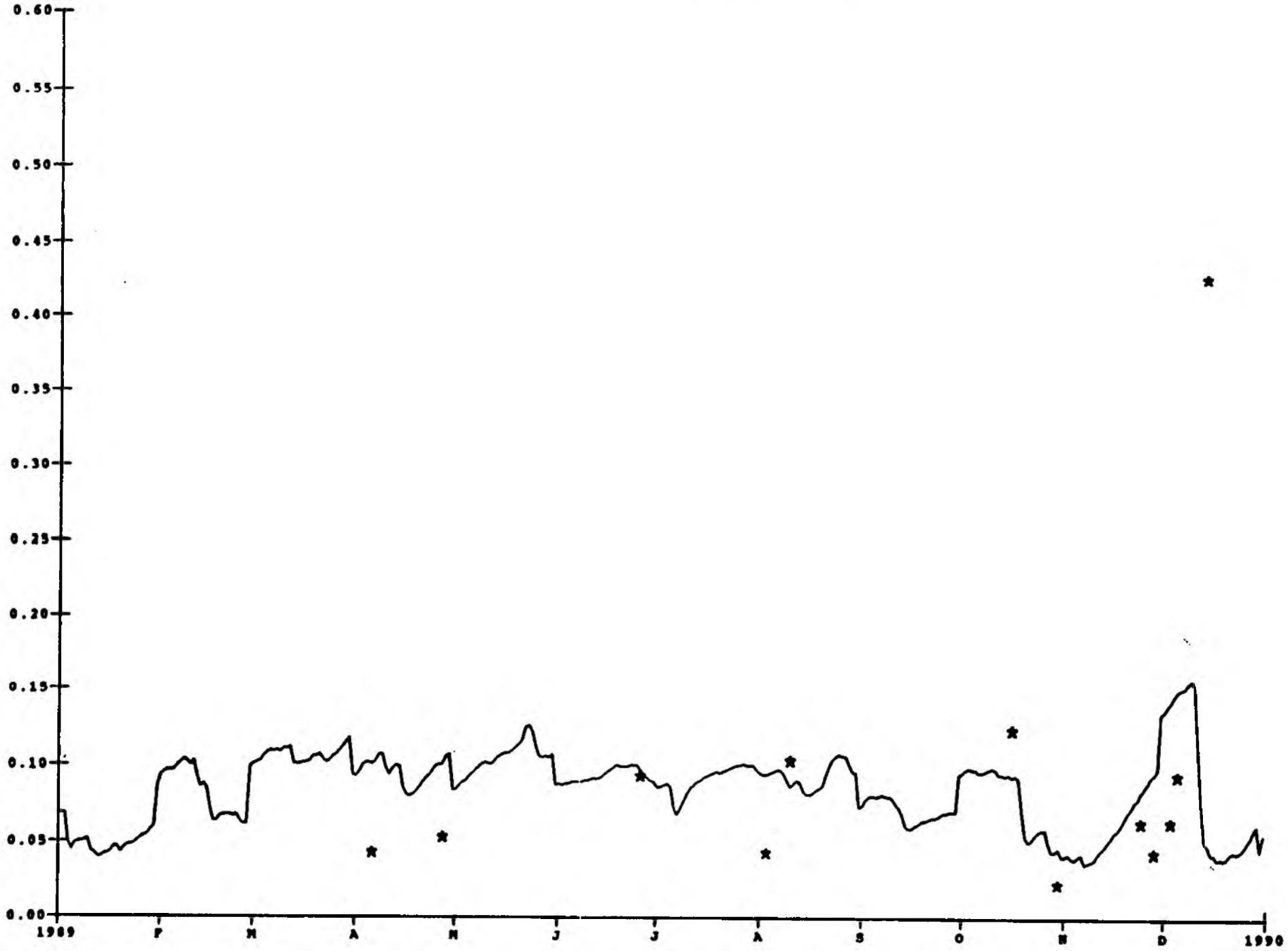
Ammonia at Compiest 1989



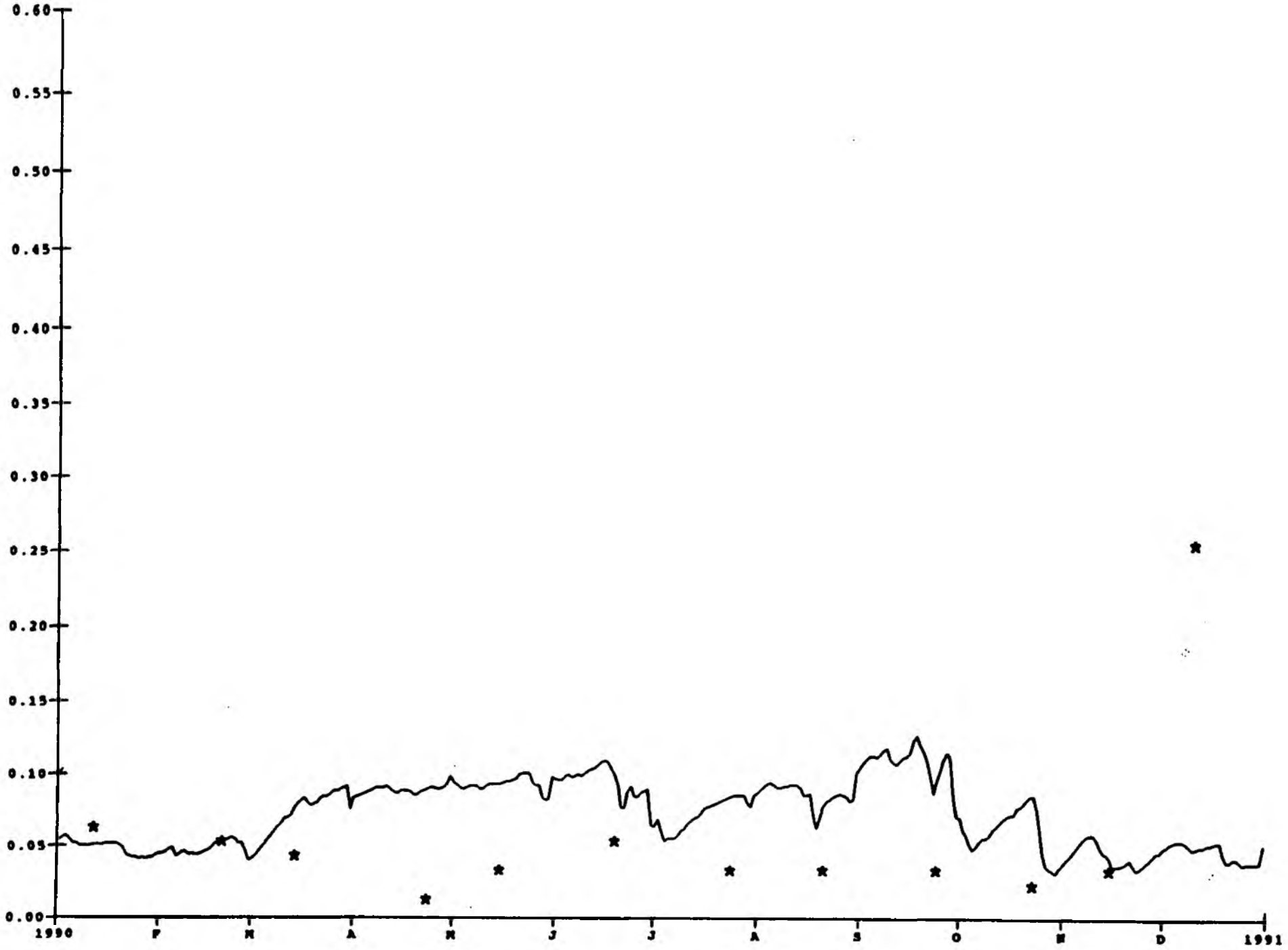
Ammonia at Colliprlest 1990



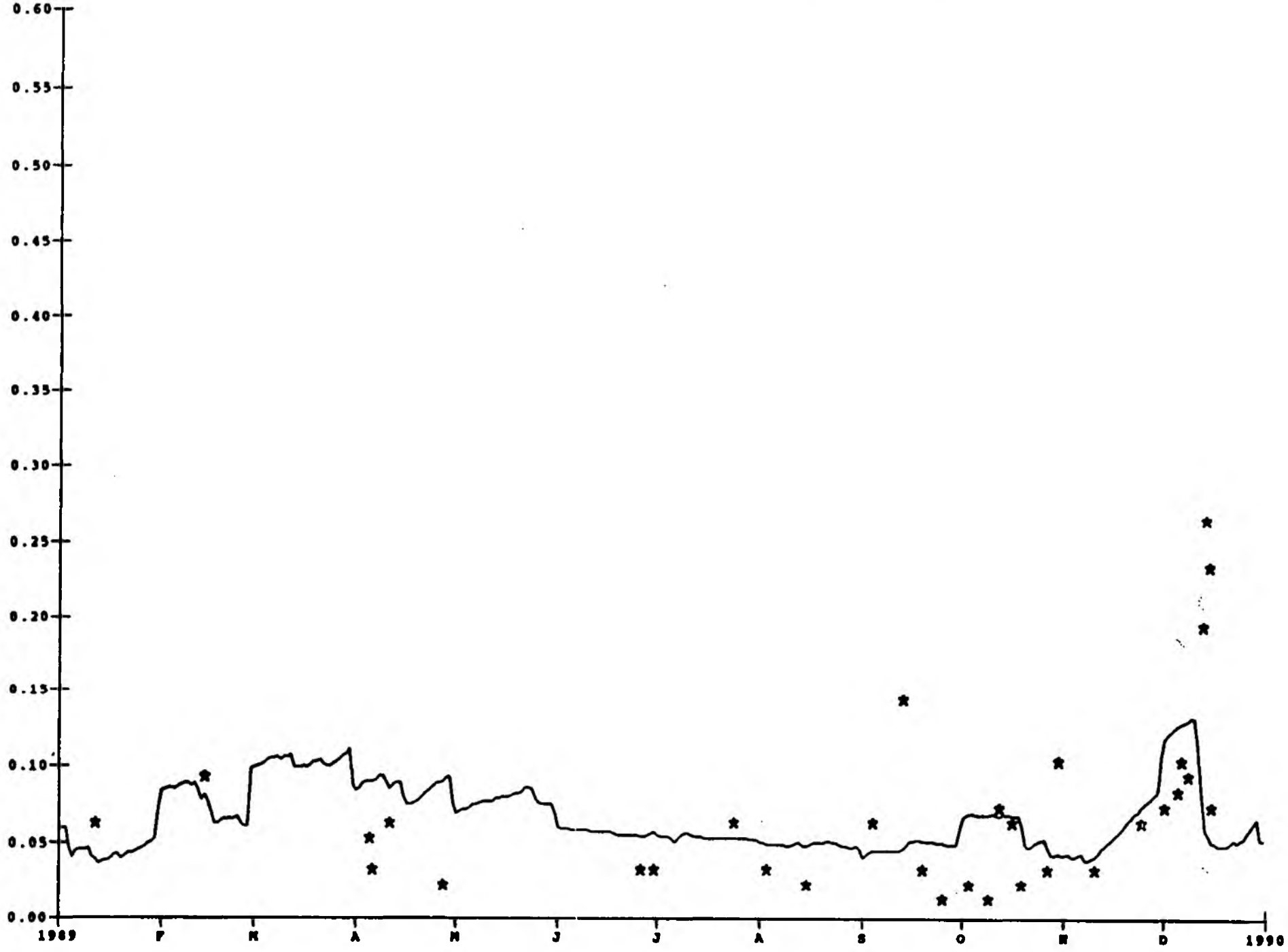
Ammonia at Ashley 1989



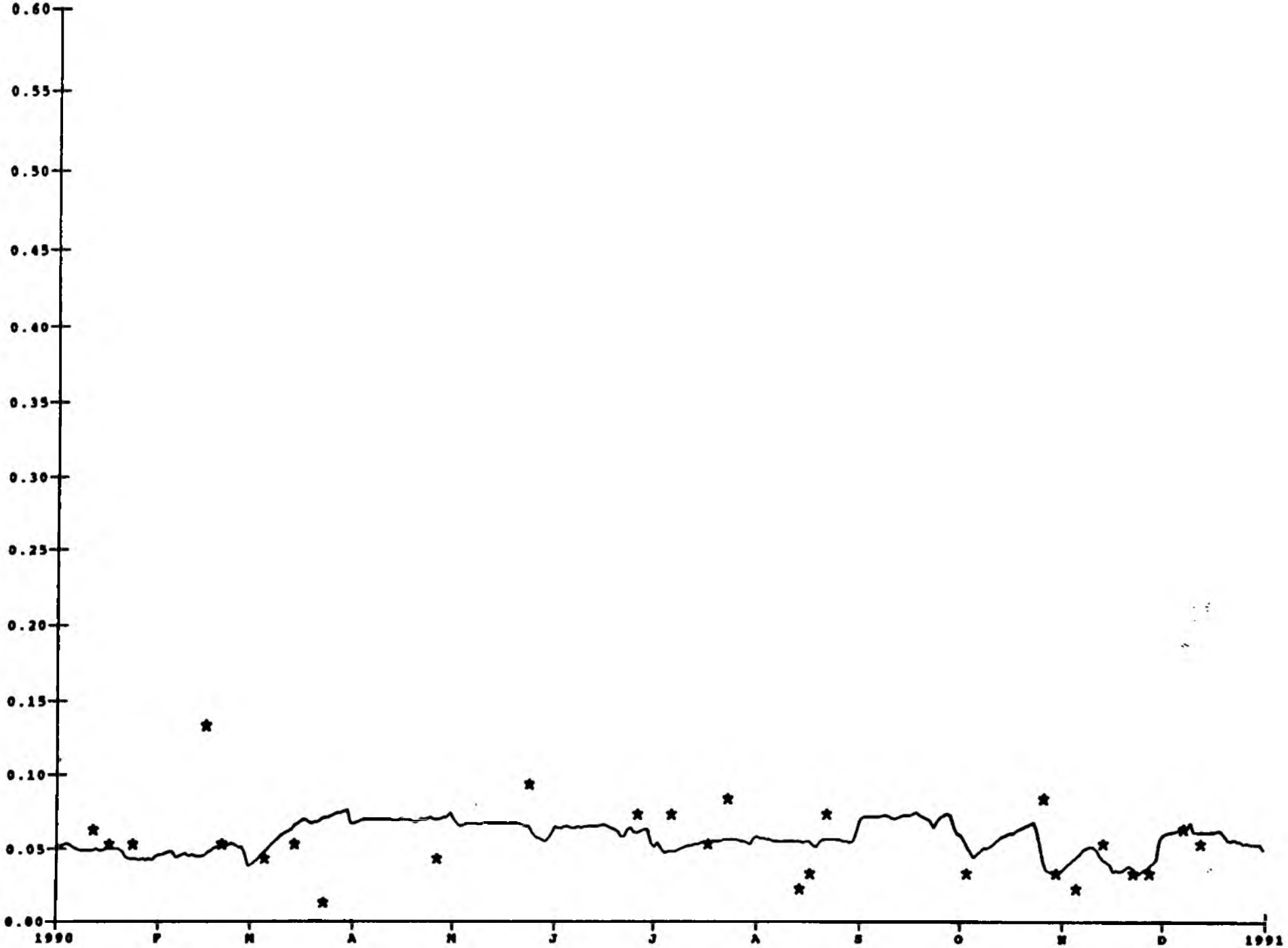
Ammonia at Ashley 1990



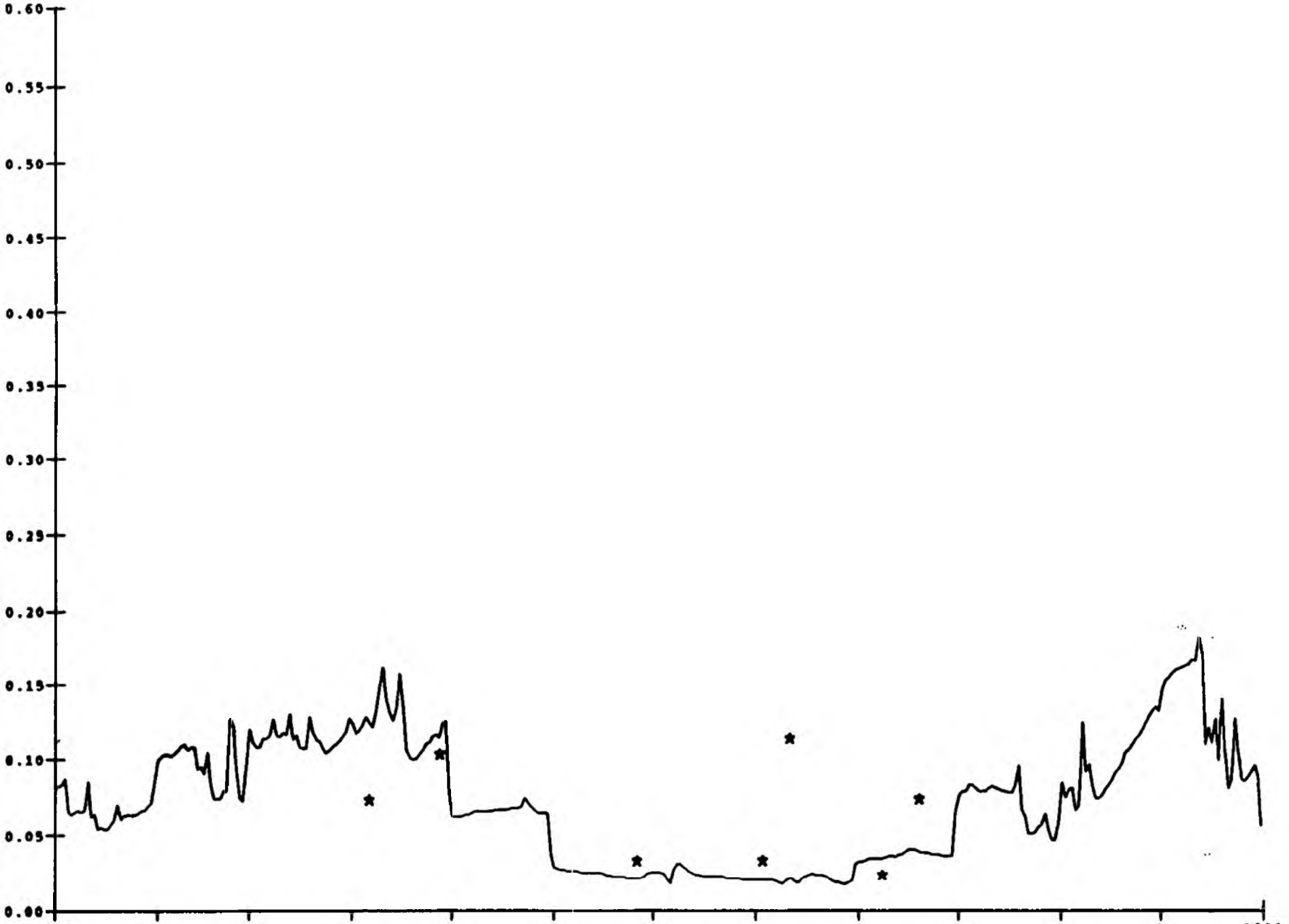
Ammonia at Thurveton 1989



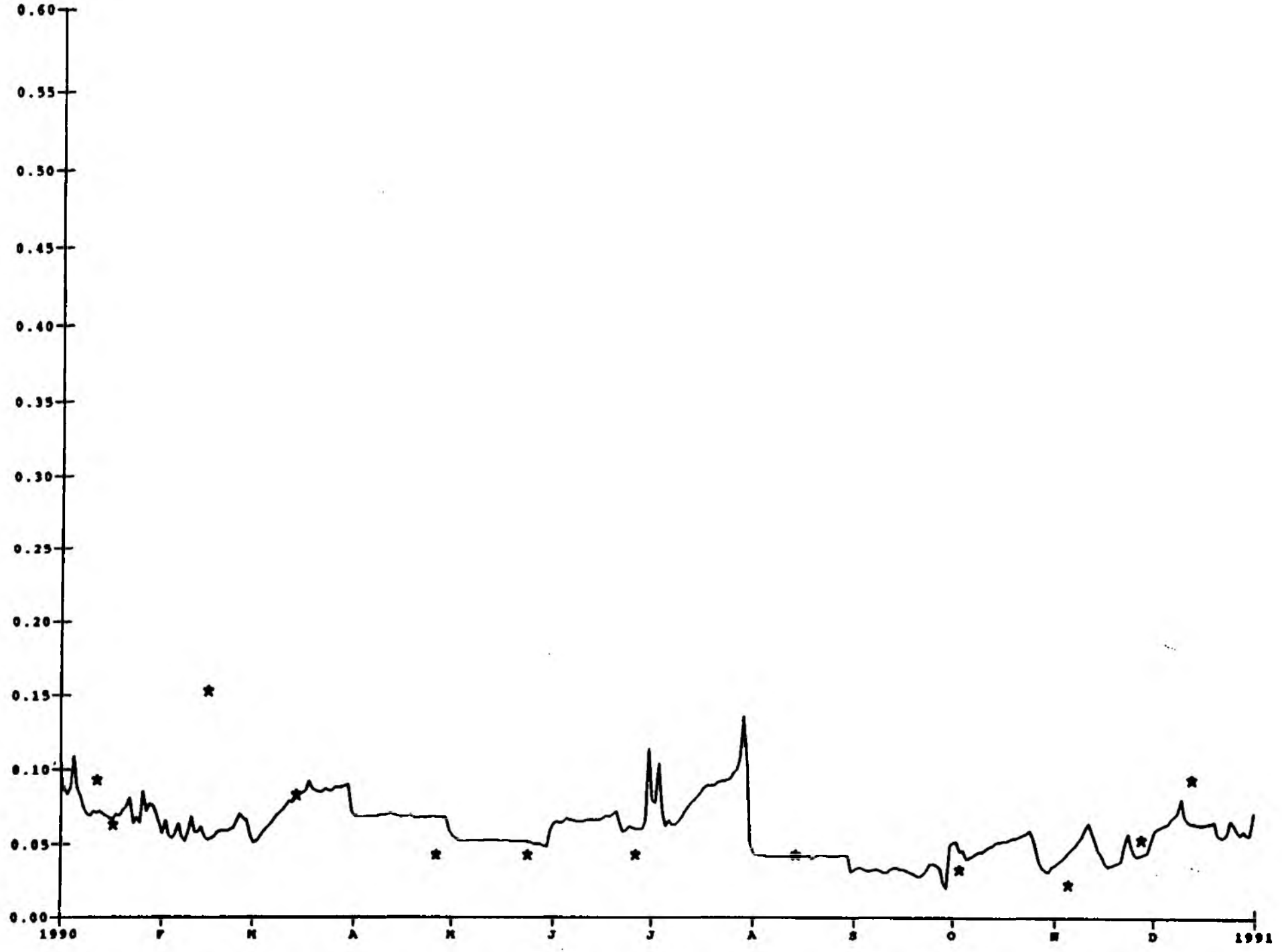
Ammonia at Thorverton 1990



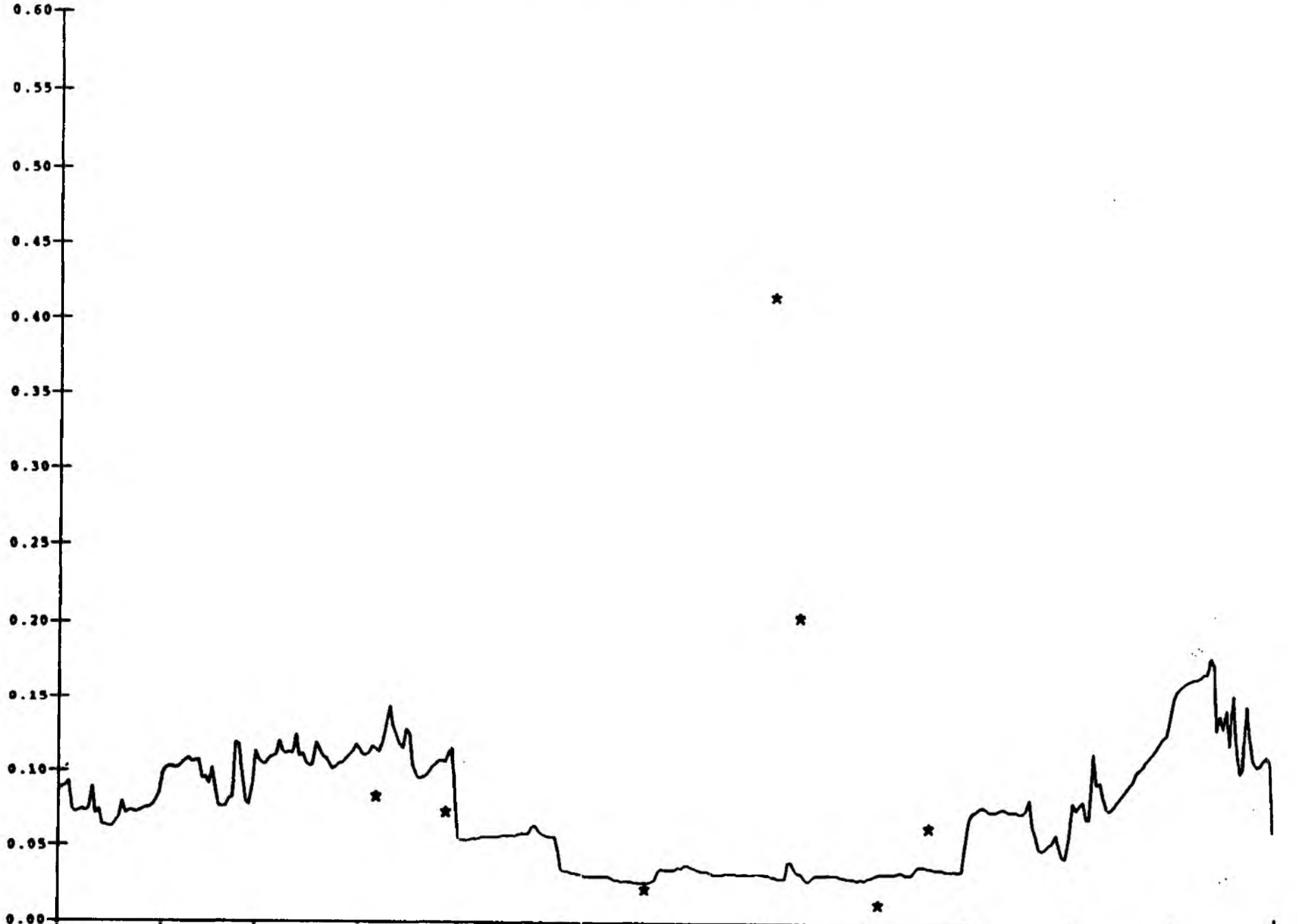
Ammonia at Stafford Br. 1989



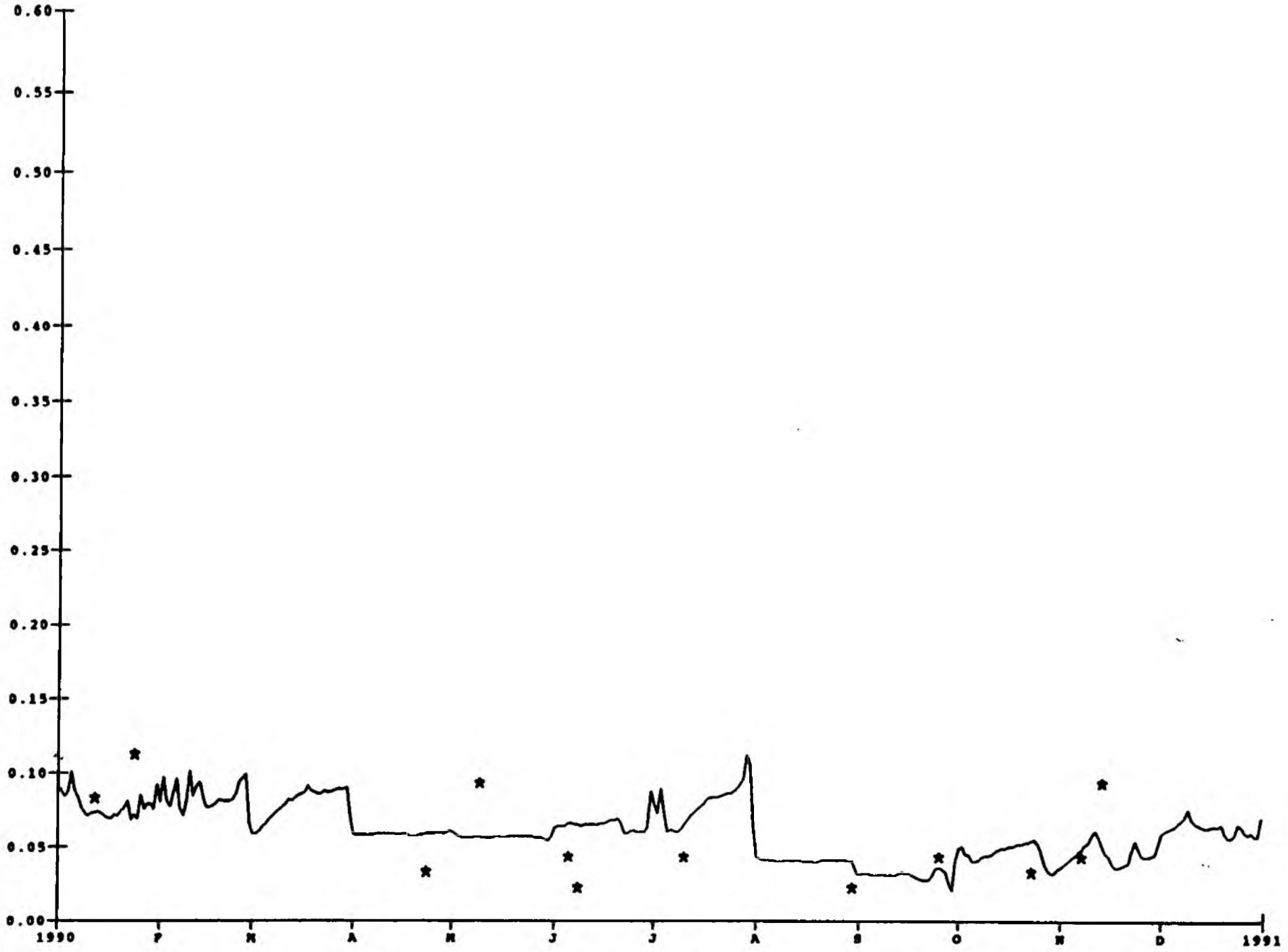
Ammonia at Stafford Br. 1990



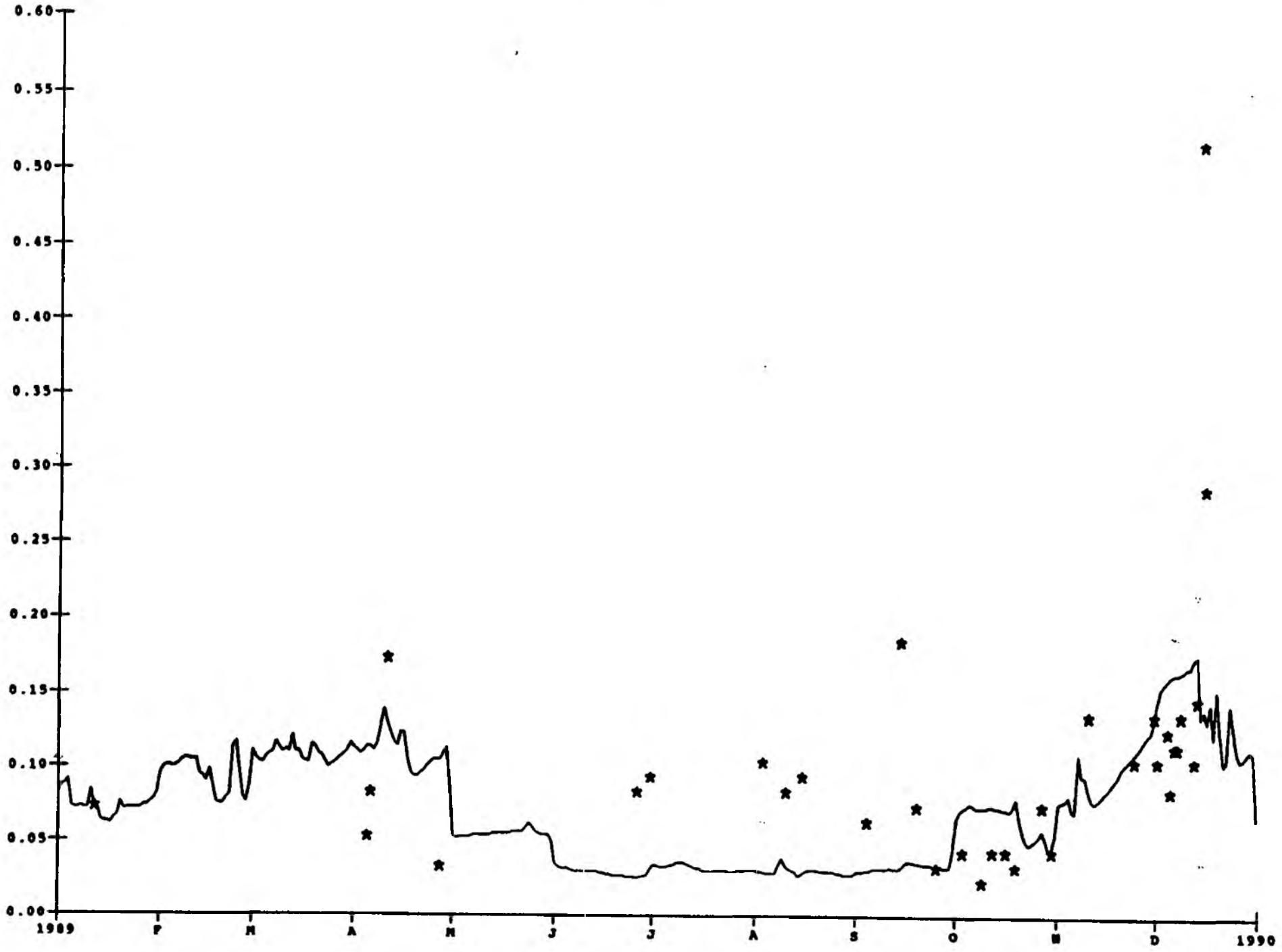
Ammonia at Exwick 1989



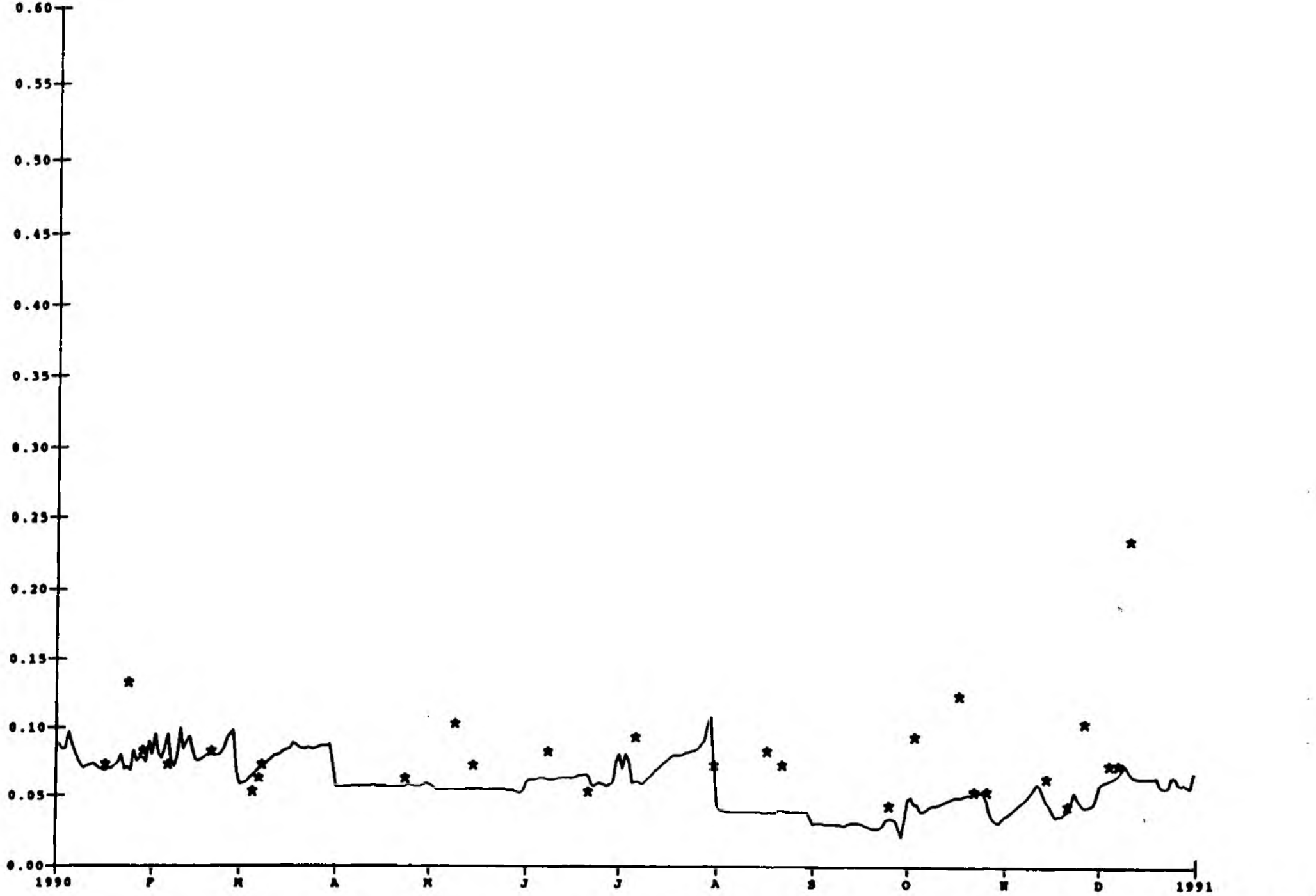
Ammonia at Exwick 1990



Ammonia at Trews Weir 1989



Ammonia at Trews Weir 1990



Appendix G – DO Profiles

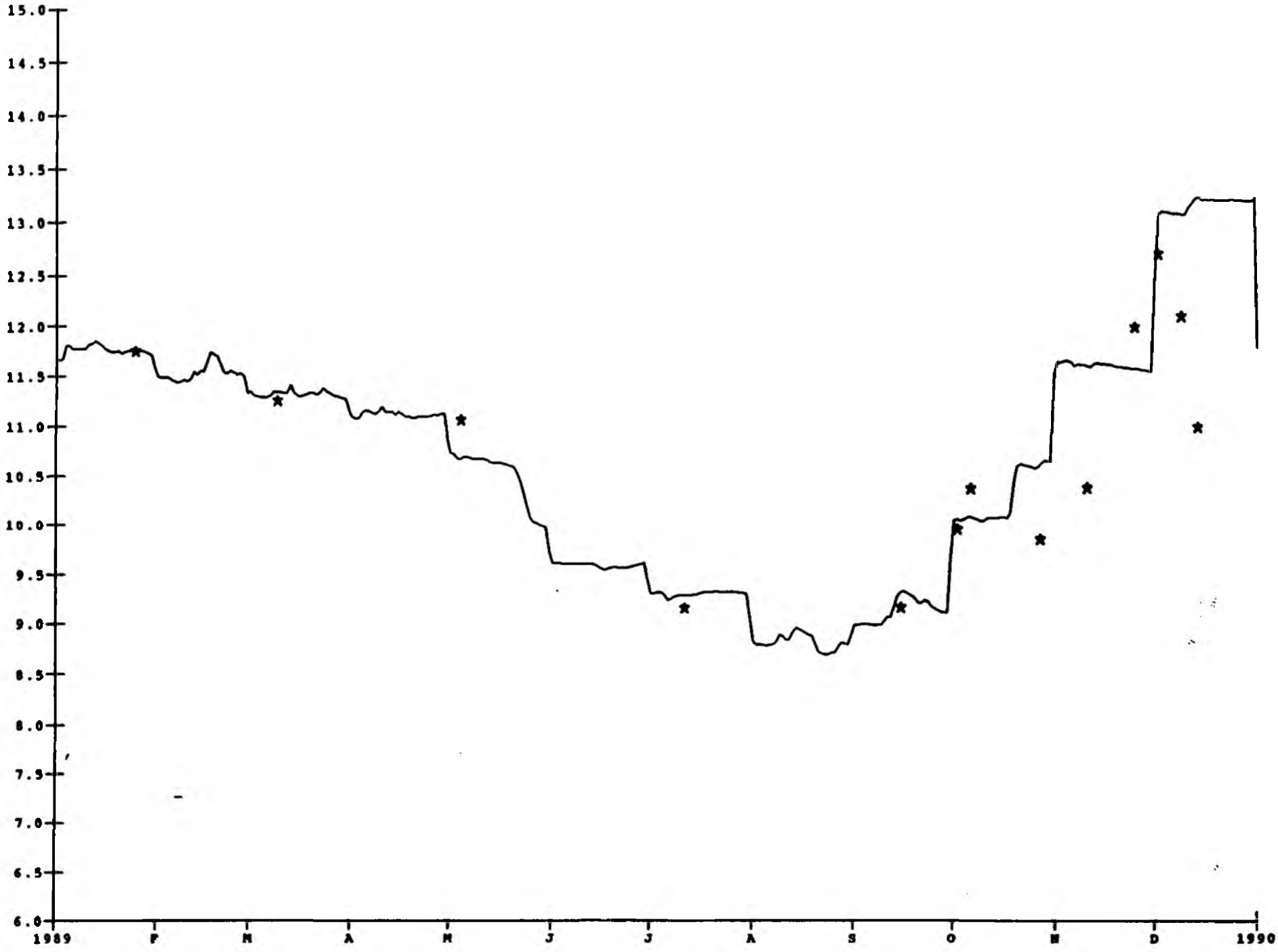
Contents:

Annual Profiles for:

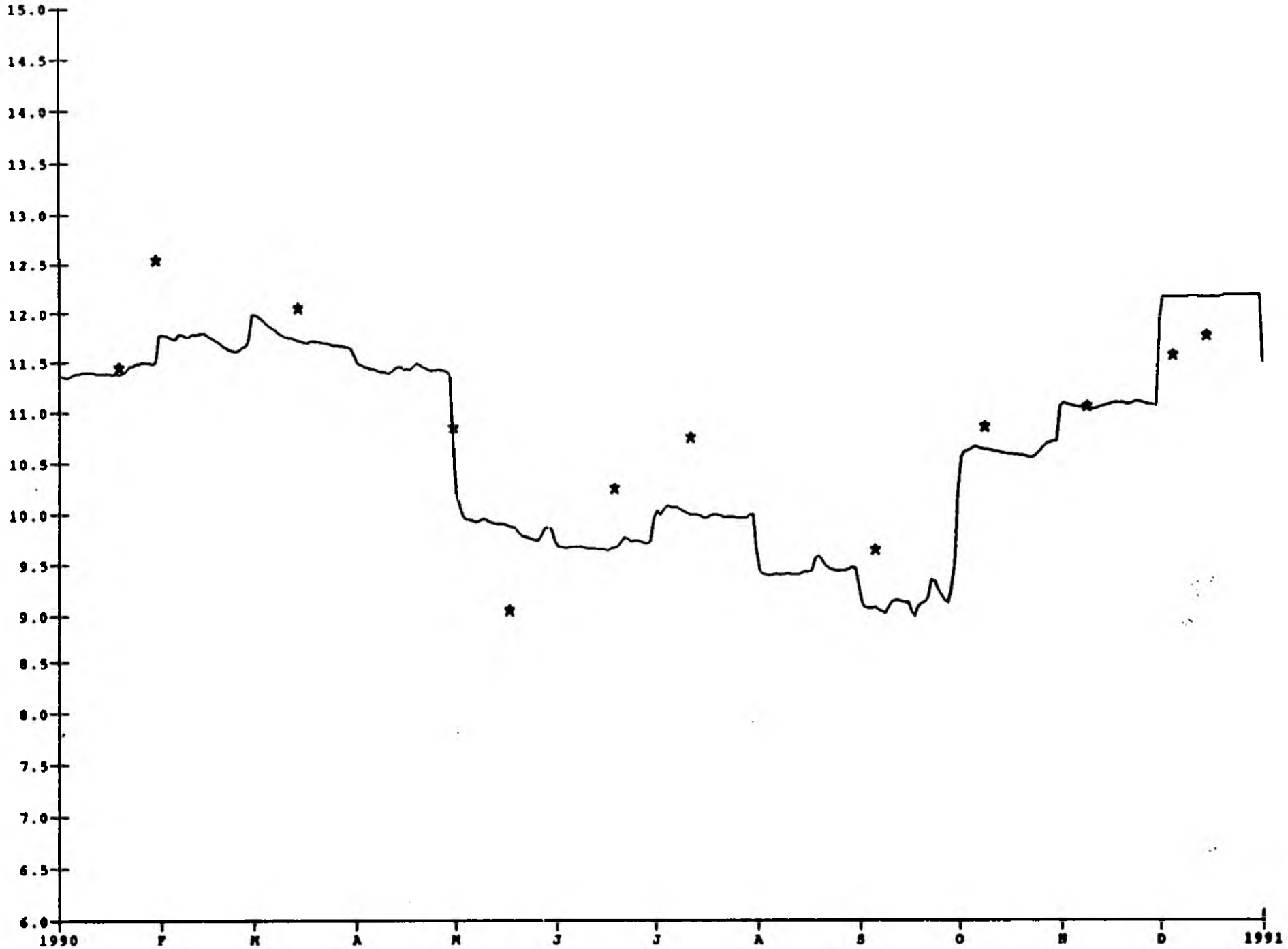
Pixton	1989
	1990
Halfpenny	1989
	1990
Tiverton	1989
	1990
Collipriest	1989
	1990
Ashley	1989
	1990
Thorverton	1989
	1990
Stafford Br.	1989
	1990
Exwick	1989
	1990
Trews Weir	1989
	1990

NB The apparent spot dissolved oxygen concentrations of 0 mgl^{-1} have arisen where there were no DO readings taken. They were therefore not included when the percentage errors were calculated.

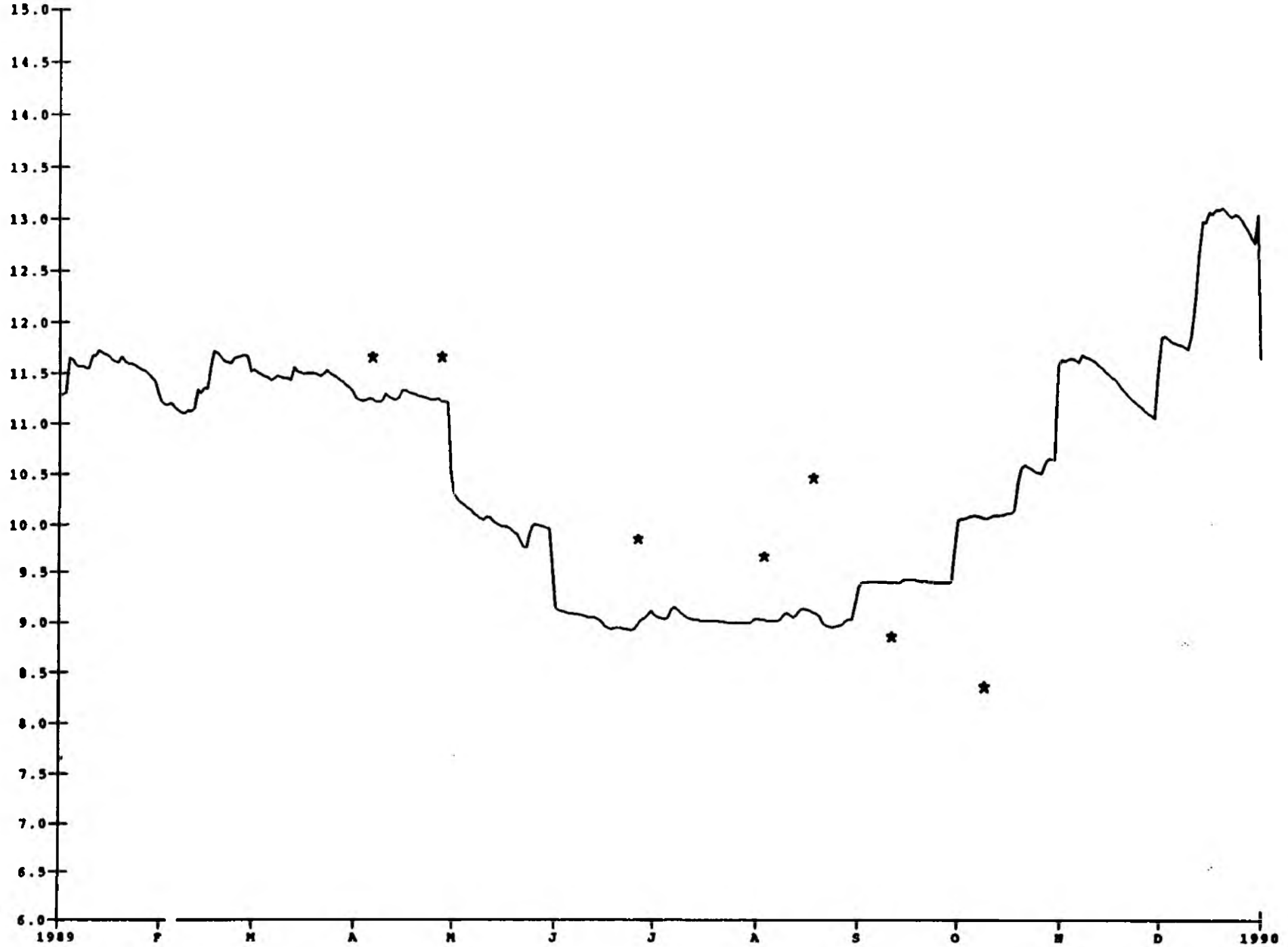
DO at Pixton 1989

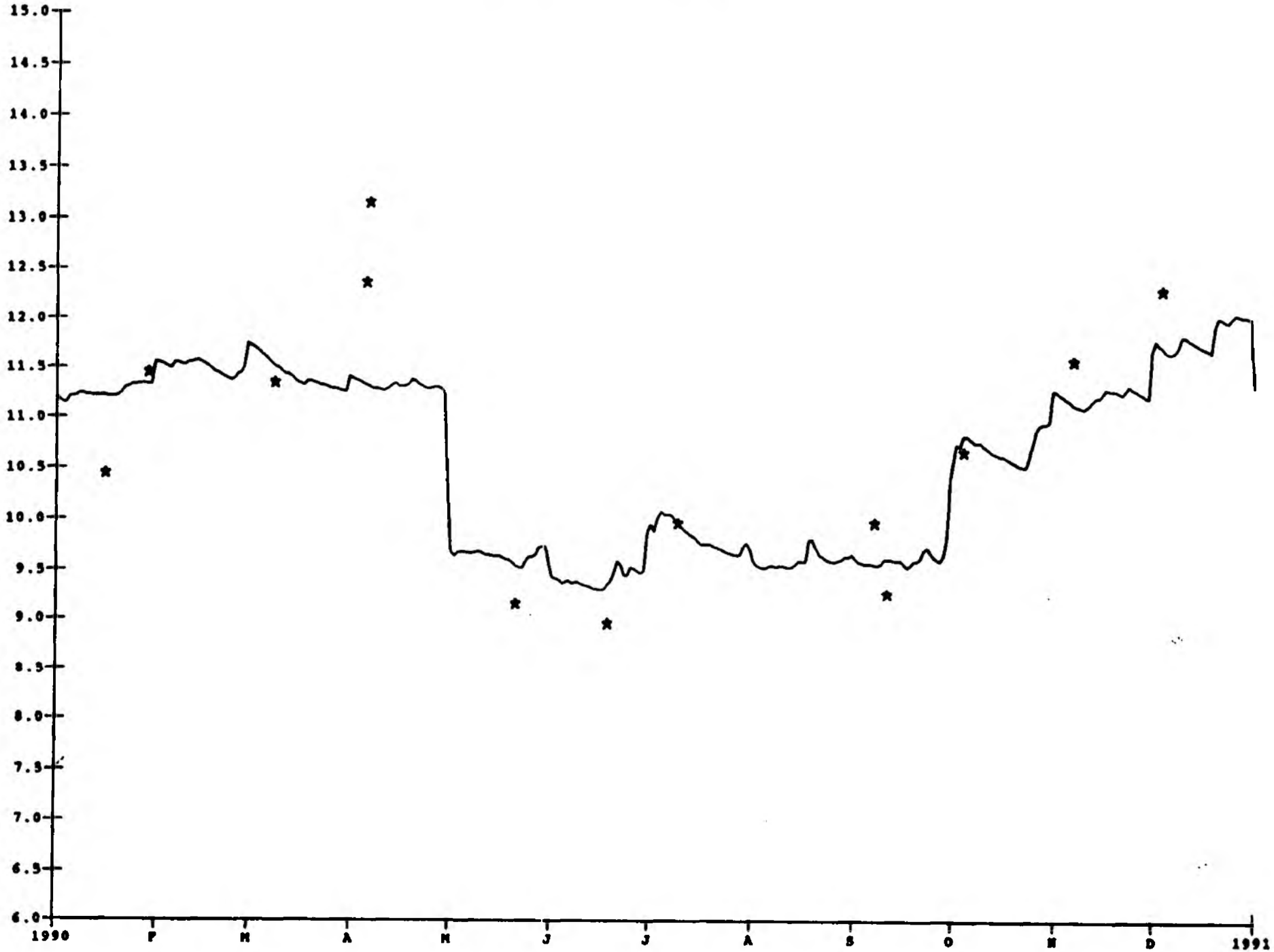


DO at Pixton 1990



DO at Halfpenny 1989

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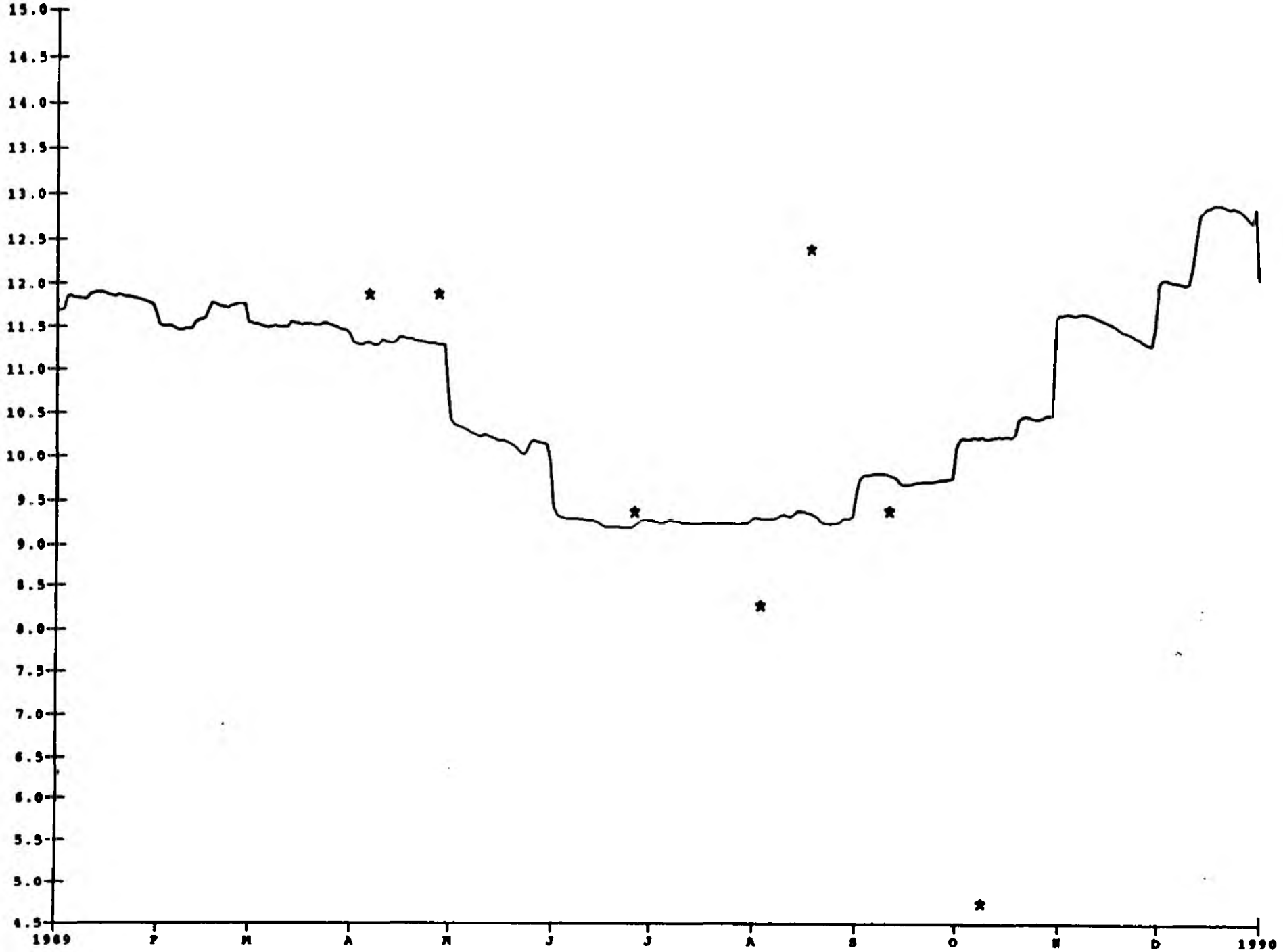
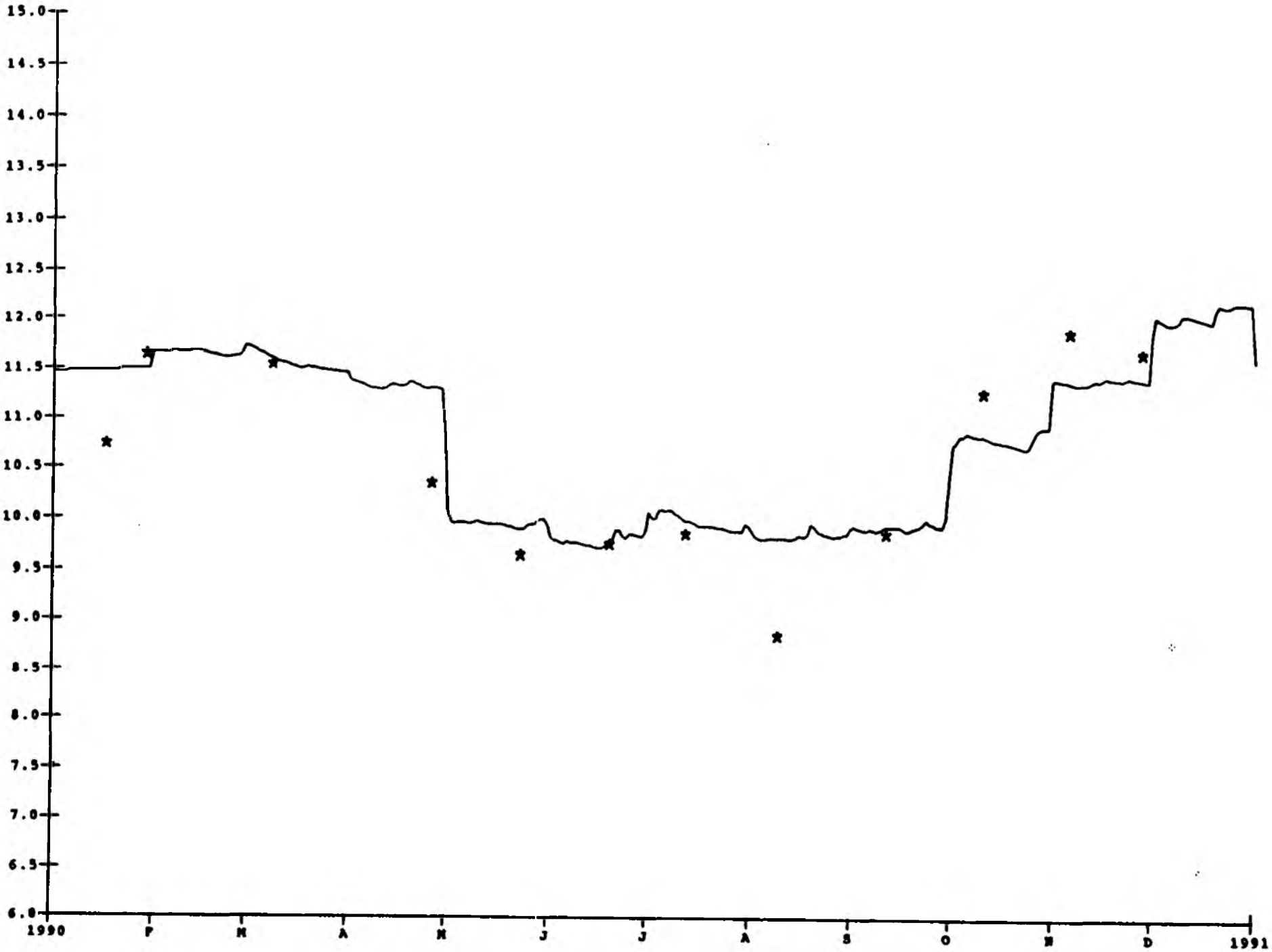
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1990
F
M
A
M
J
J
A
S
O
N
D
1991

DO at Tiverton 1989

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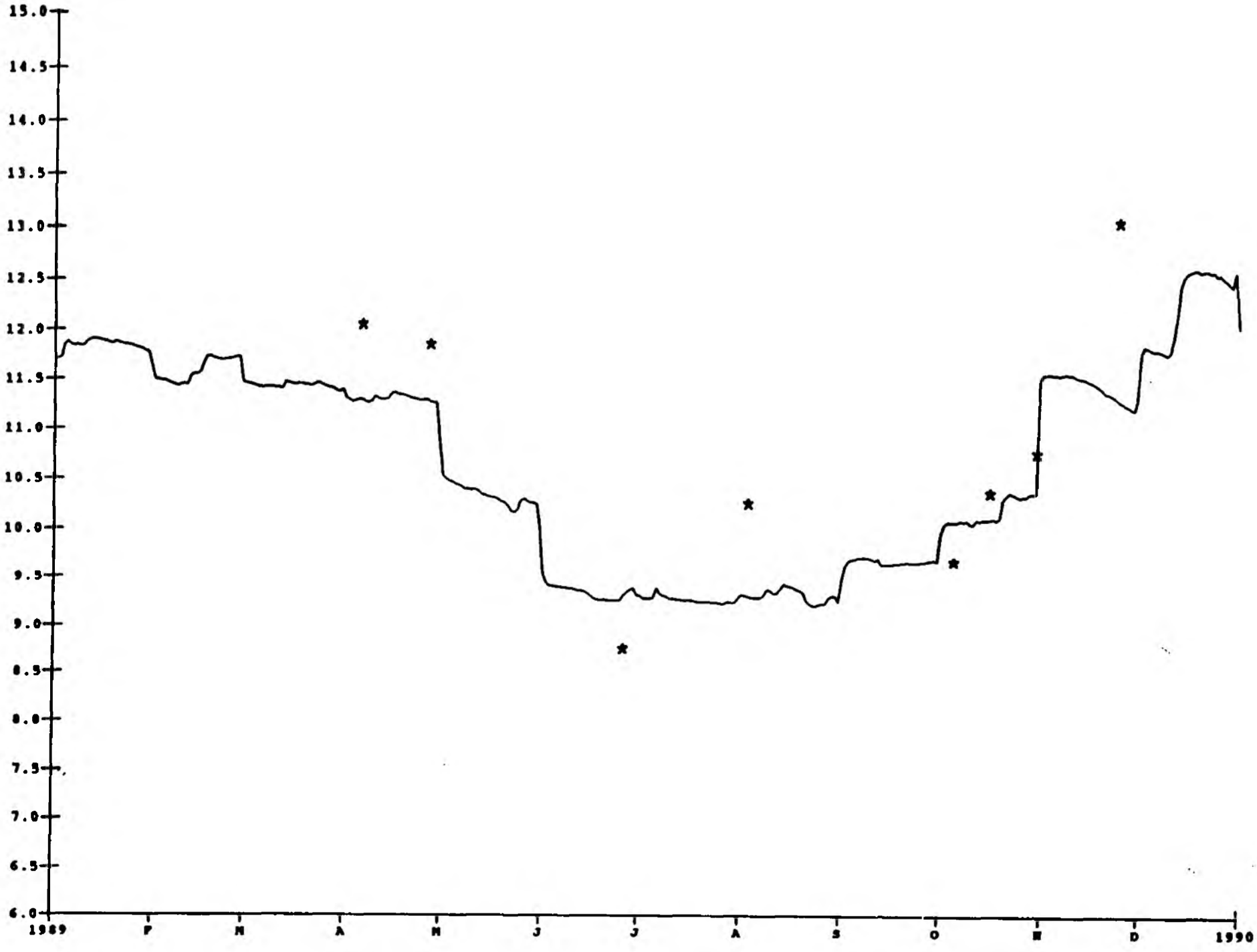
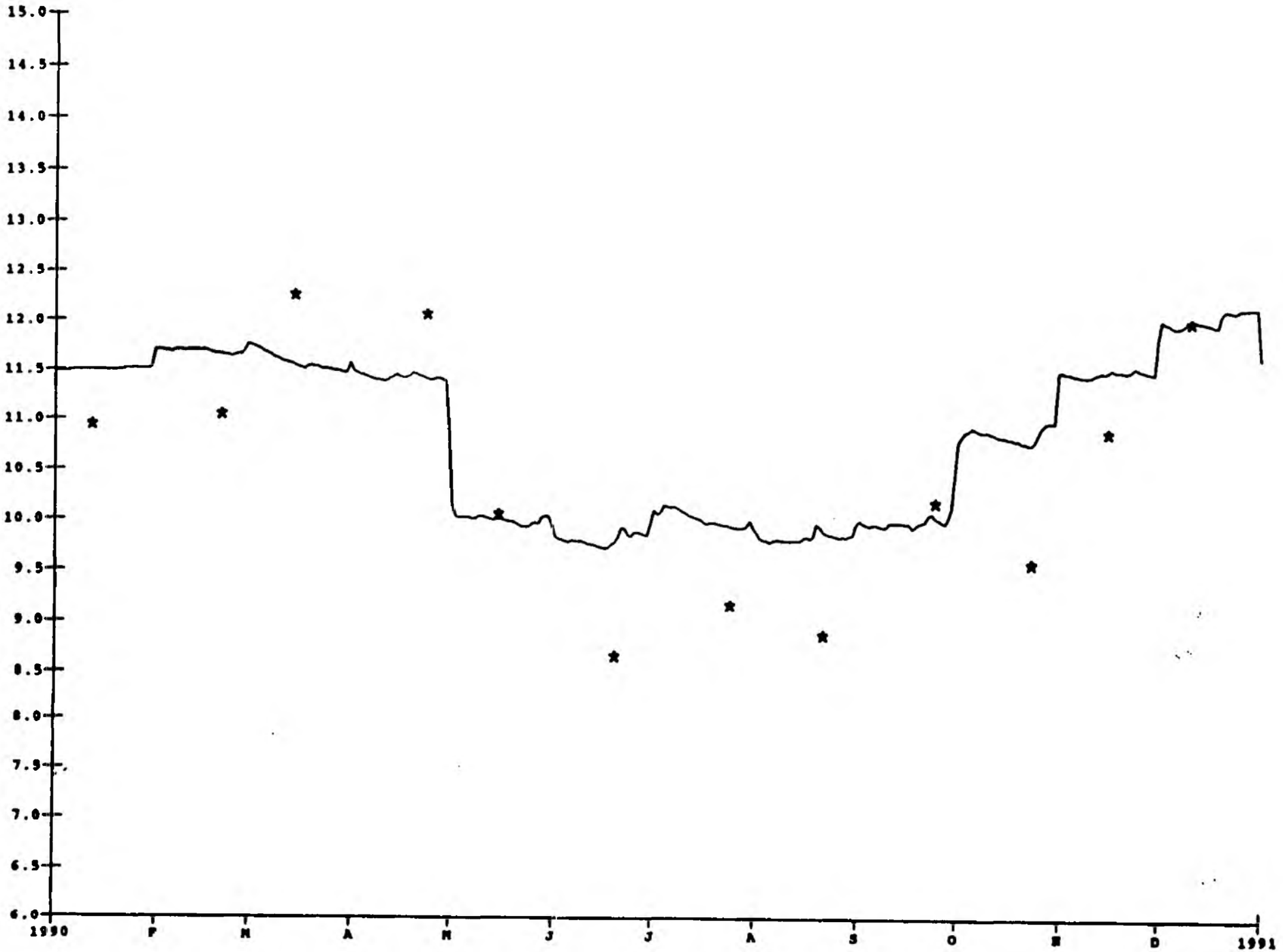
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1990
F
M
A
M
J
J
A
S
O
N
D
1991

DO at Collipriest 1989

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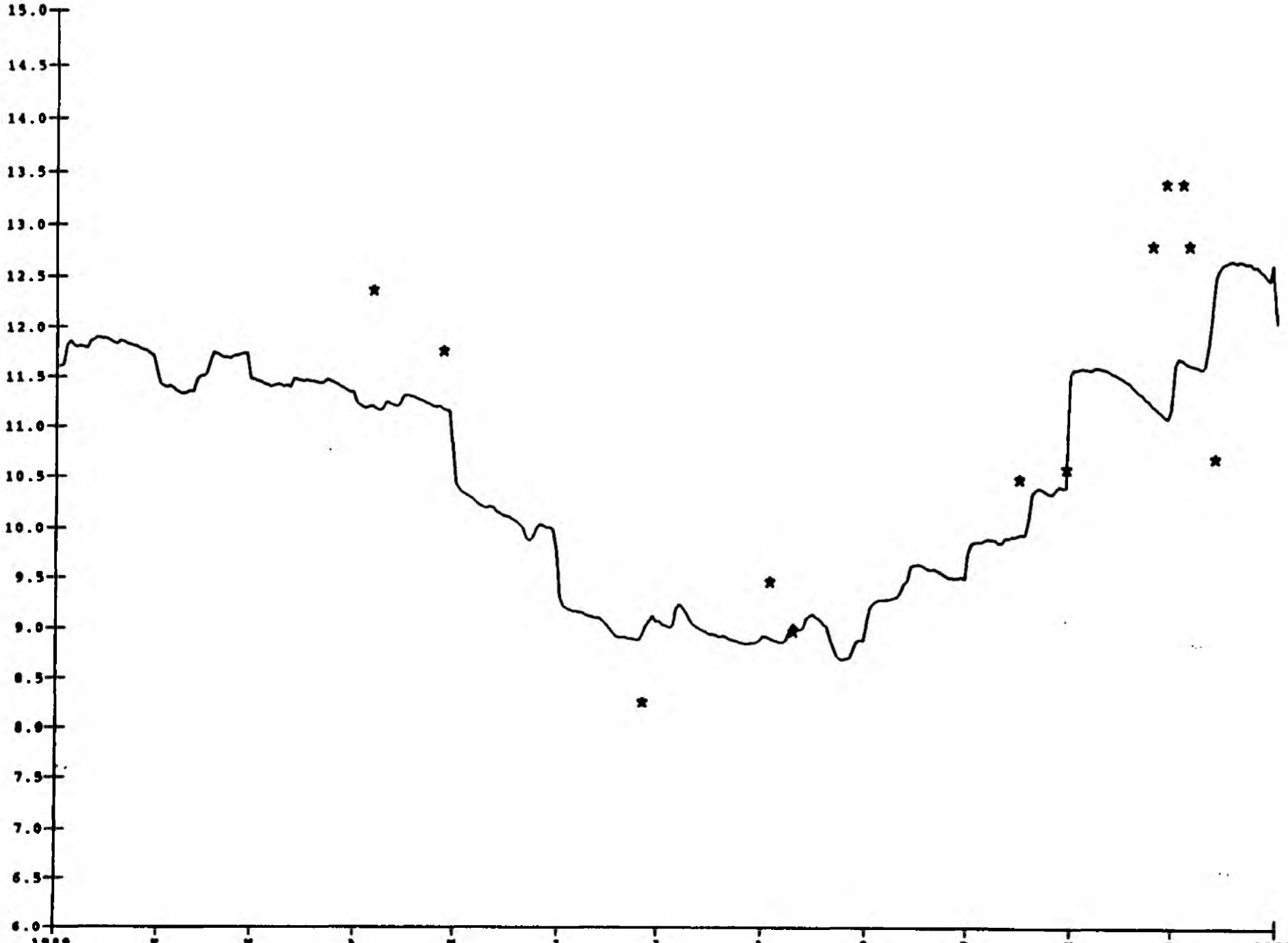
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1990
F
M
A
M
J
J
A
S
O
N
D
1991

DO at Ashley 1989



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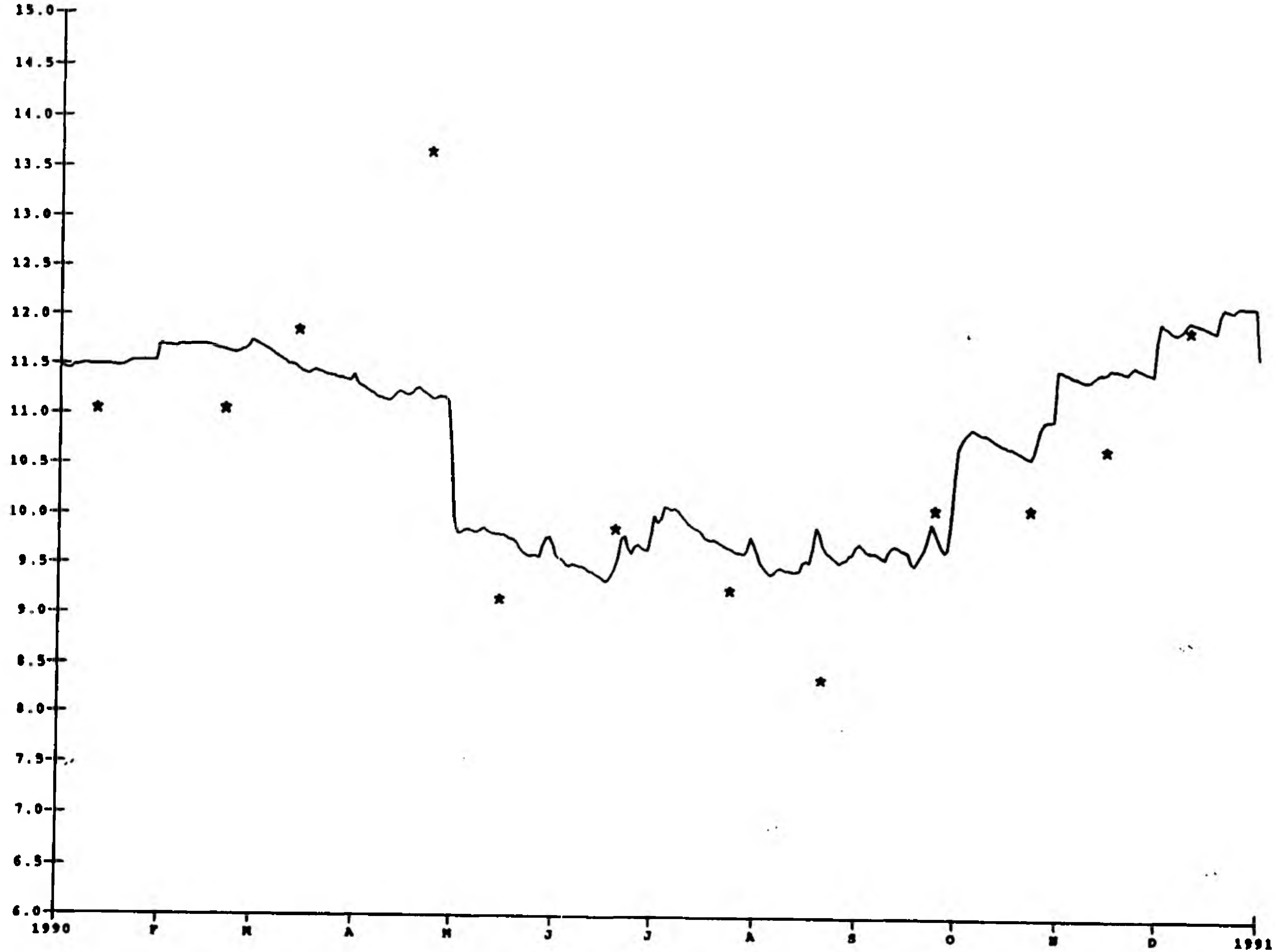

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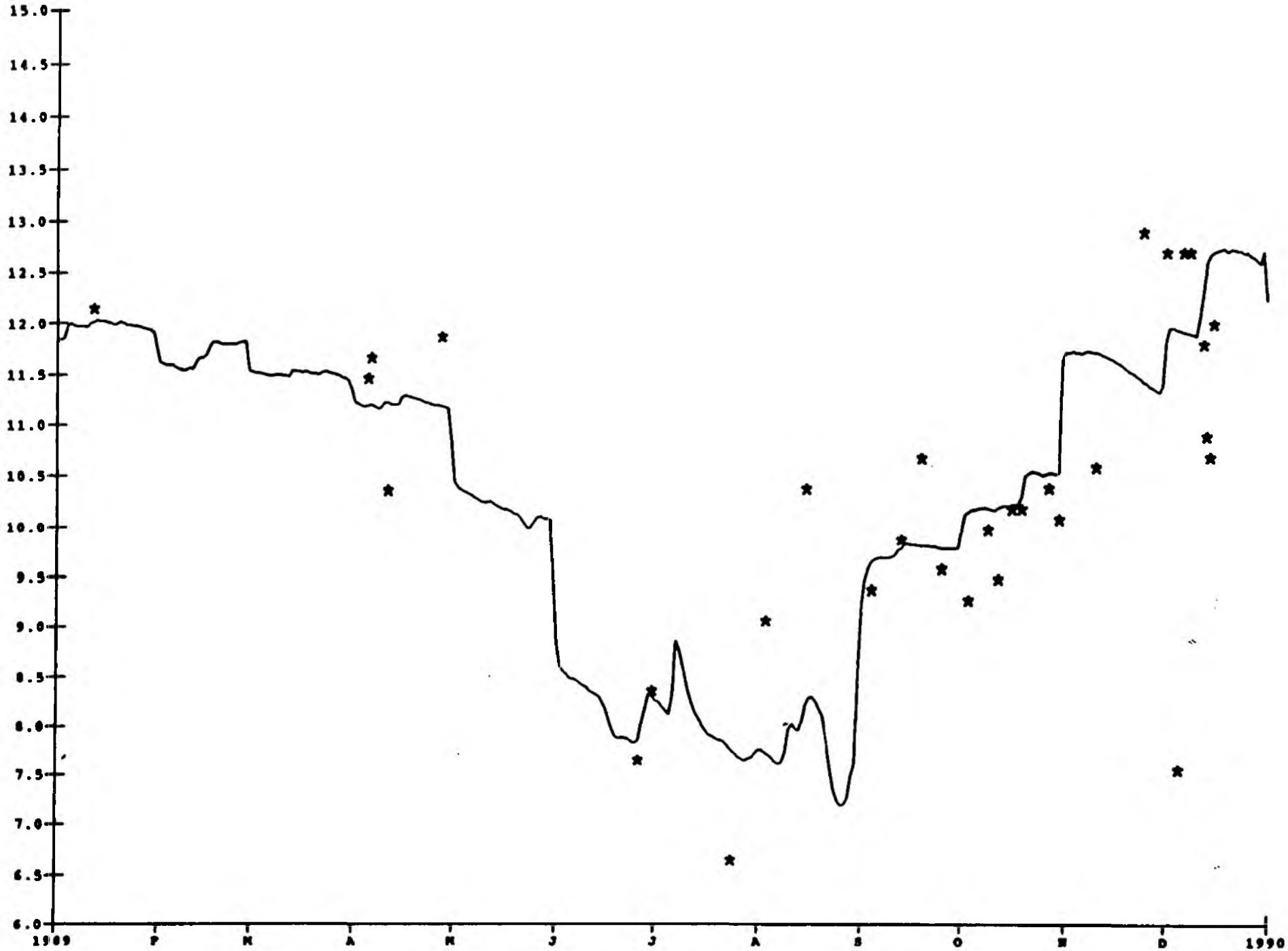

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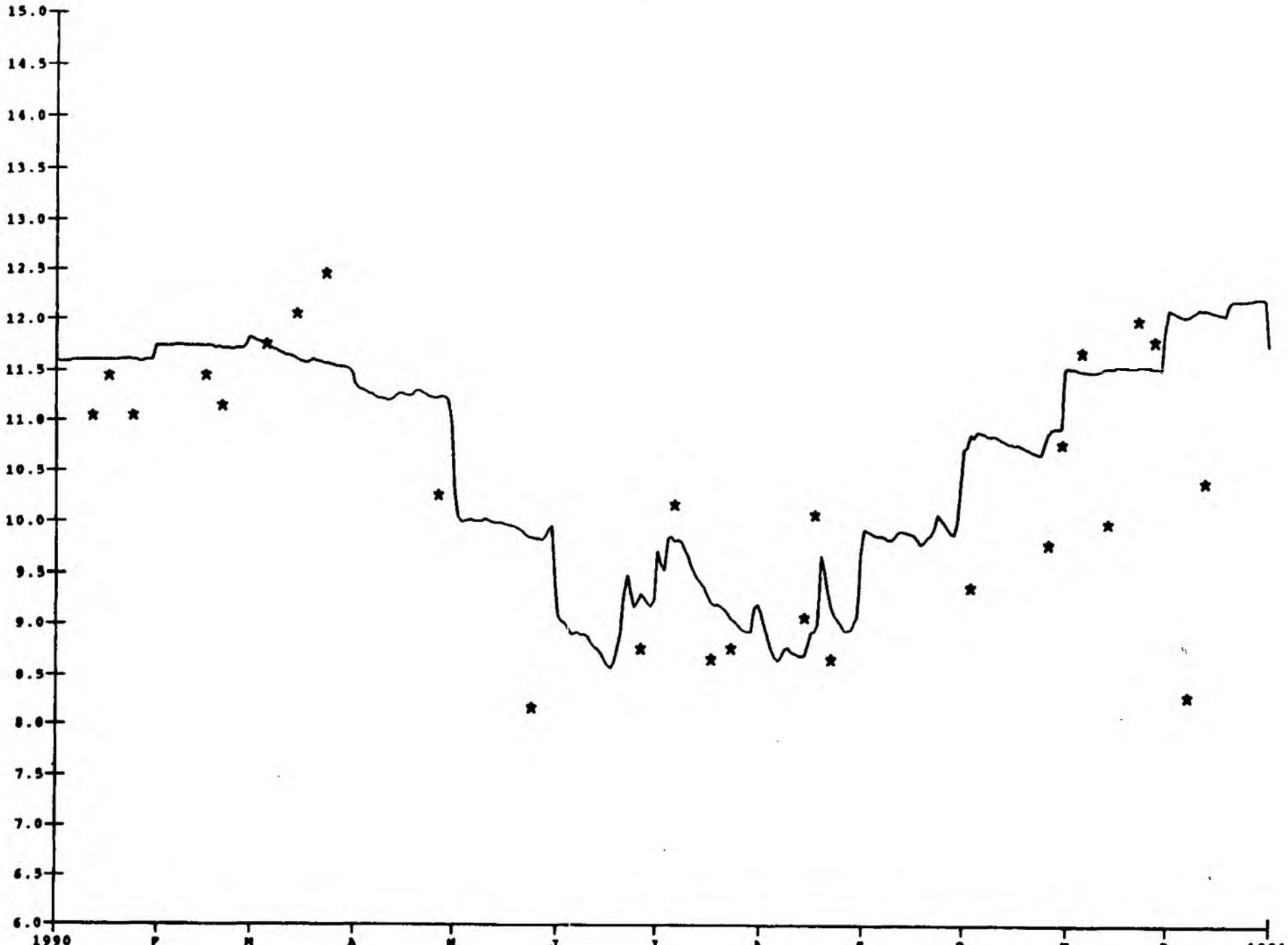

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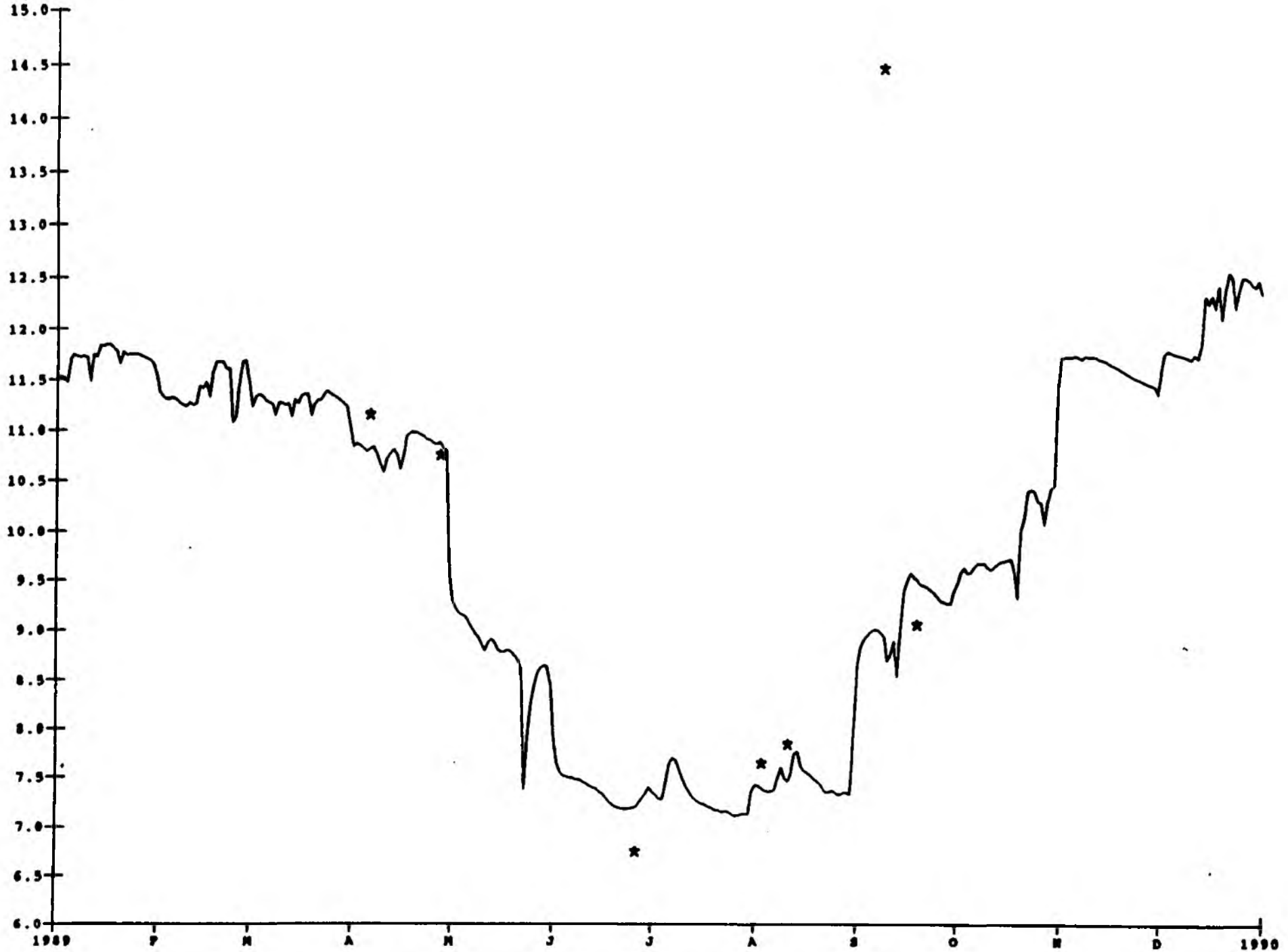

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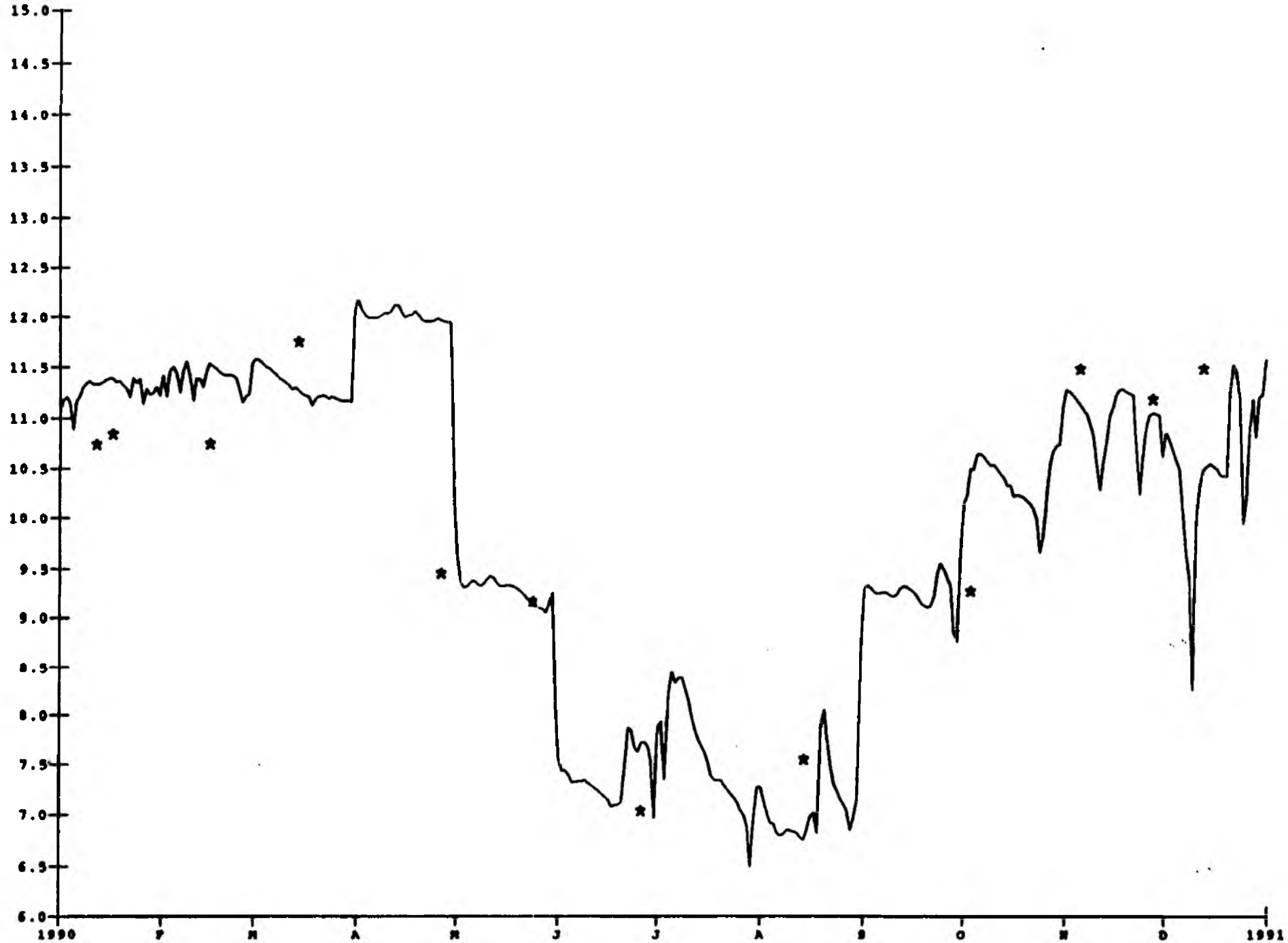

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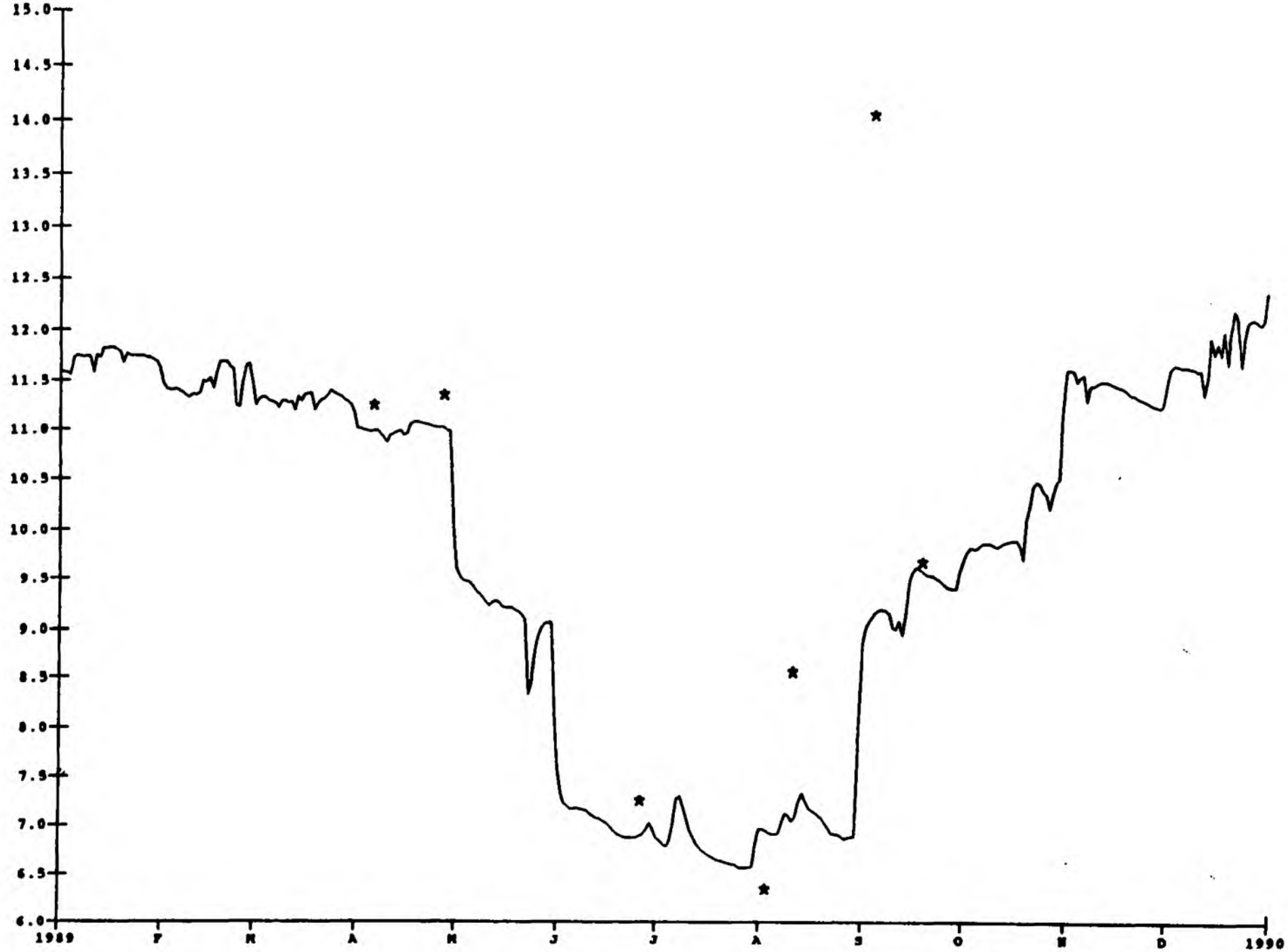
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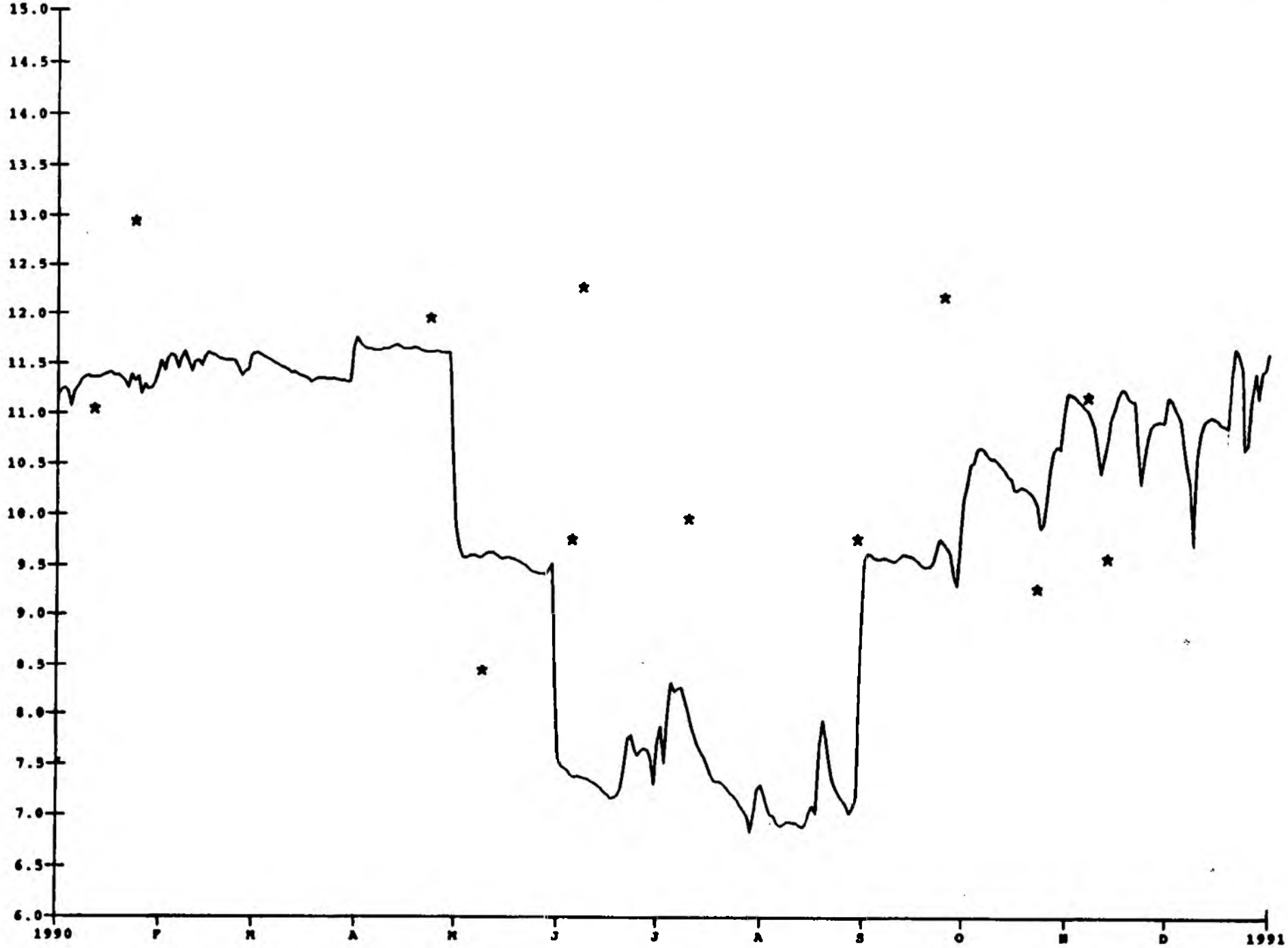

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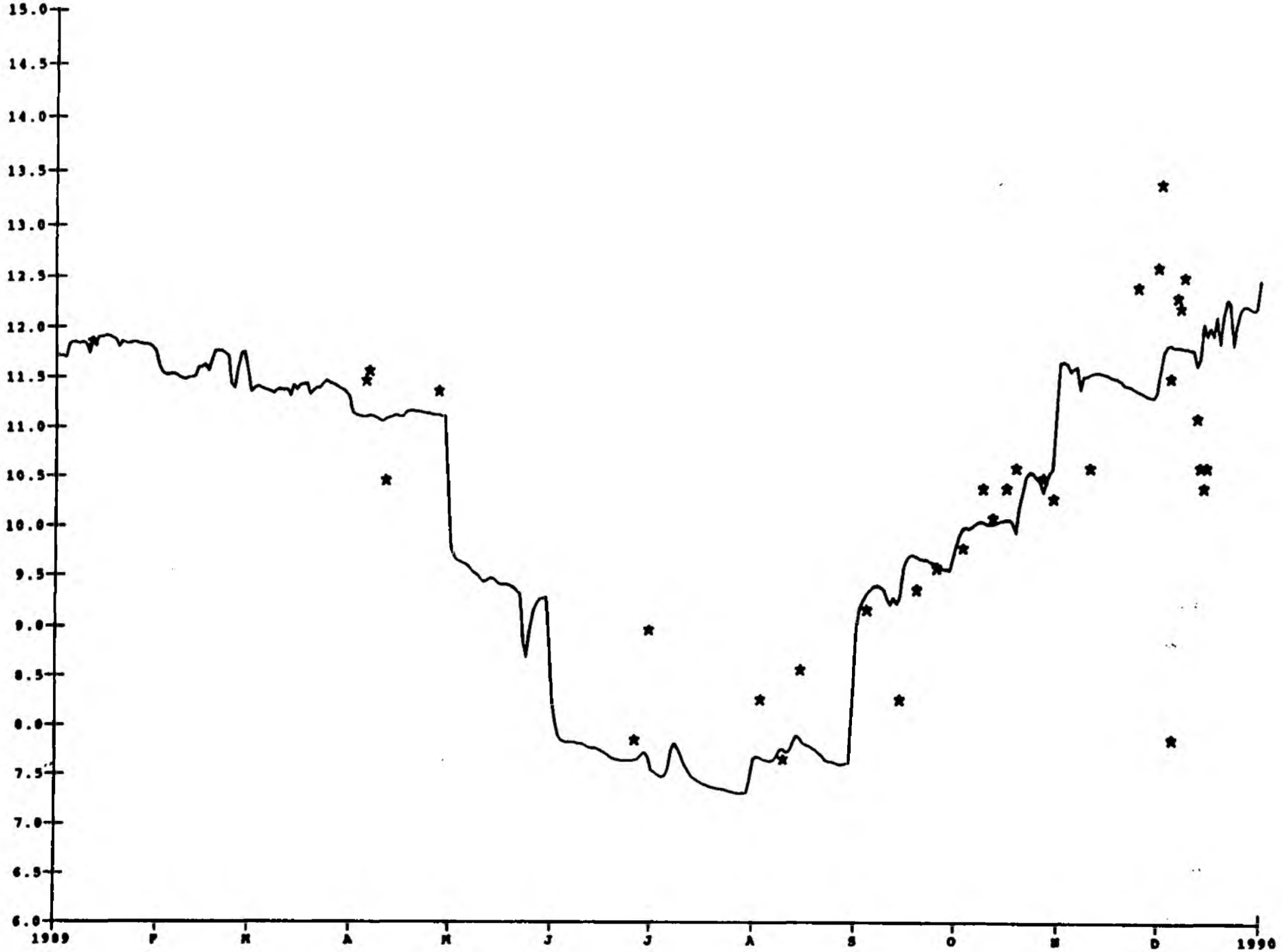

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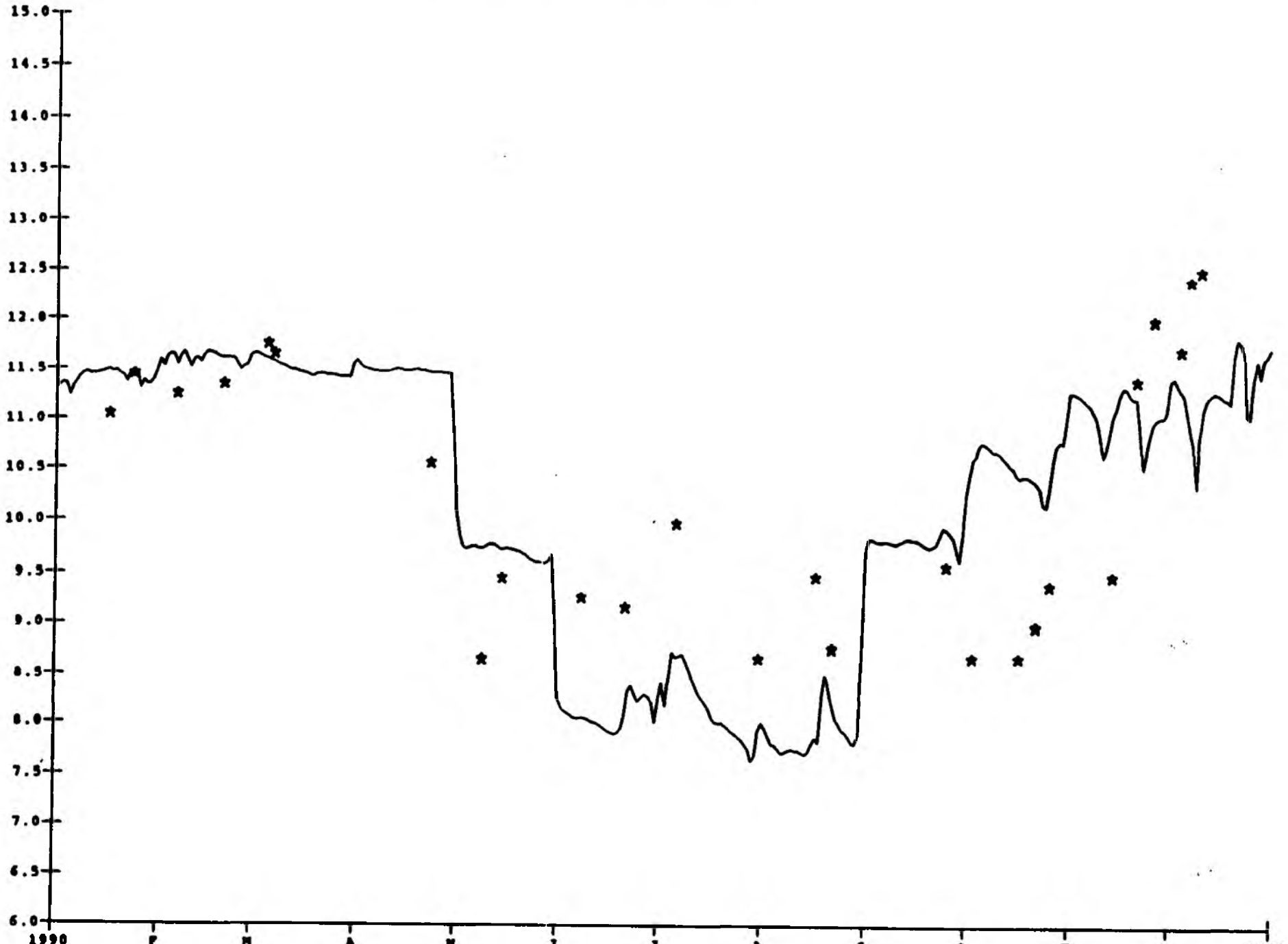

Appendix H Spot Sample Data Sources and Values

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Pixton 1989 URN=R05G005

	Nitrate	DO	BOD	Ammonia	Temperature		pH
25-JAN-89	2.1	11.7	0.9	0.01	6.5	0	7.4
09-MAR-89	2.1	11.2	1.4	0.04	8.5	0	7.3
04-MAY-89	1.7	11.0	1.1	0.02	14.0	0	7.8
11-JUL-89	1.6	9.1	1.1	0.03	18.0	0	7.4
15-SEP-89	1.3	9.1	1.4	0.02	16.0	0	7.5
02-OCT-89	0.9	9.9	0.7	0.01	11.5	0	7.5
06-OCT-89	0.8	10.3	1.0	0.01	10.0	0	7.5
27-OCT-89	2.1	9.8	1.1	0.01	12.5	0	7.4
10-NOV-89	2.5	10.3	0.8	0.01	10.0	0	7.2
24-NOV-89	2.1	11.9	1.3	0.02	5.6	0	7.3
01-DEC-89	2.2	12.6	2.2	0.01	5.0	0	7.5
08-DEC-89	2.1	12.0	0.5	0.03	6.5	0	7.5
13-DEC-89	1.8	10.9	2.8	0.09	8.0	0	7.5

Pixton 1990 URN=R05G005

	Nitrate	DO	BOD	Ammonia	Temperature		pH
19-JAN-90	2.70	11.4	0.5	0.05	7.0	0	7.1
30-JAN-90	2.30	12.5	2.6	0.02	8.0	0	7.2
14-MAR-90	2.50	12.0	1.7	0.01	8.0	0	7.4
30-APR-90	2.32	10.8	1.1	0.05	10.5	0	7.7
17-MAY-90	1.60	9.0	2.3	0.03	12.0	0	7.4
18-JUN-90	2.00	10.2	2.8	0.04	13.5	0	7.4
11-JUL-90	2.00	10.7	1.9	0.04	13.0	0	7.5
05-SEP-90	2.00	9.6	2.4	0.02	14.0	0	7.5
08-OCT-90	1.50	10.8	1.9	0.03	9.0	0	7.5
08-NOV-90	2.20	11.0	2.8	0.03	8.5	0	7.2
04-DEC-90	2.90	11.5	1.7	0.05	5.5	0	7.1
14-DEC-90	2.61	11.7	1.4	0.04	4.5	0	7.1

Halfpenny Bridge 1989 URN=R05E002

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
06-APR-89	1.7	11.6	1.5	0.06	11.0	0	7.5
27-APR-89	1.3	11.6	1.5	0.05	8.0	0	7.6
26-JUN-89	1.4	9.8	1.6	0.07	18.5	0	7.5
03-AUG-89	1.1	9.6	1.2	0.04	18.0	0	7.7
18-AUG-89	1.1	10.4	1.2	0.05	15.0	0	7.6
11-SEP-89	1.2	8.8	1.3	0.09	12.5	0	7.4
09-OCT-89	1.1	8.3	1.3	0.03	12.0	0	7.6

Halfpenny Bridge 1990 URN=R05E002

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
16-JAN-90	1.60	10.4	1.2	0.05	9.5	0	7.2
29-JAN-90	2.40	11.4	1.2	0.03	9.0	0	7.0
08-MAR-90	1.90	11.3	1.0	0.06	6.5	0	7.3
05-APR-90	1.29	12.3	1.3	0.06	3.5	0	7.4
06-APR-90	1.29	13.1	1.8	0.06	7.0	0	7.1
21-MAY-90	1.70	9.1	2.0	0.15	12.0	0	7.4
18-JUN-90	1.50	8.9	2.8	0.14	13.0	0	7.3
09-JUL-90	0.70	9.9	0.9	0.05	14.0	0	7.3
07-SEP-90	1.20	9.9	0.9	0.16	12.5	0	7.5
11-SEP-90	1.20	9.2	1.9	0.12	10.0	0	7.2
04-OCT-90	0.40	10.6	2.2	0.05	10.0	0	7.1
06-NOV-90	1.40	11.5	0.9	0.03	8.0	0	7.2
03-DEC-90	1.86	12.2	1.6	0.05	7.5	0	7.1

Tiverton 1989 URN-R05E004

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
06-APR-89	2.1	11.8	1.3	0.03	11.5	0	7.6
27-APR-89	1.6	11.8	1.4	0.04	8.0	0	7.8
26-JUN-89	1.9	9.3	1.9	0.02	17.5	0	7.6
03-AUG-89	1.3	8.2	1.0	0.02	21.0	0	7.8
18-AUG-89	1.2	12.3	1.3	0.05	17.0	0	8.0
11-SEP-89	1.6	9.3	1.6	0.04	13.0	0	7.5
09-OCT-89	1.2	4.7	2.9	0.03	13.0	0	7.5

Tiverton 1990 URN=R05E004

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
17-JAN-90	1.90	10.7	1.1	0.05	8.1	0	7.3
29-JAN-90	3.00	11.6	0.7	0.03	8.0	0	7.2
08-MAR-90	2.50	11.5	1.2	0.06	8.0	0	7.4
26-APR-90	1.40	10.3	2.4	0.02	11.8	0	7.7
23-MAY-90	2.10	9.6	2.2	0.07	14.0	0	7.5
19-JUN-90	1.78	9.7	2.2	0.05	14.0	0	7.6
12-JUL-90	1.00	9.8	1.0	0.05	15.0	0	...
09-AUG-90	1.70	8.8	0.8	0.03	15.0	0	7.6
11-SEP-90	1.55	9.8	0.9	0.03	13.0	0	7.5
10-OCT-90	0.80	11.2	1.0	0.03	12.5	0	7.3
05-NOV-90	1.60	11.8	1.5	0.03	7.0	0	7.1
27-NOV-90	3.50	11.6	0.5	0.03	7.0	0	7.1

Colliprieat 1989 URN=R05E005

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
06-APR-89	2.3	12.0	2.3	0.05	13.0	0	7.7
27-APR-89	1.7	11.8	2.1	0.05	9.0	0	7.7
26-JUN-89	1.6	8.7	2.4	0.07	18.0	0	7.7
03-AUG-89	1.3	10.2	1.3	0.03	18.0	0	7.8
05-OCT-89	0.8	9.6	1.3	0.14	11.0	0	7.4
16-OCT-89	1.0	10.3	2.1	0.02	11.7	0	7.4
30-OCT-89	1.8	10.7	1.9	0.02	12.3	0	7.0
24-NOV-89	5.6	13.0	1.4	0.05	9.0	0	7.9

Collipriest 1990 URM-R05E005

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-90	2.60	10.9	0.9	0.10	8.5	0	7.3
20-FEB-90	2.60	11.0	1.6	0.06	10.1	0	7.2
14-MAR-90	4.70	12.2	2.1	0.05	9.0	0	8.0
23-APR-90	1.72	12.0	2.0	0.01	12.5	0	8.8
15-MAY-90	3.50	10.0	2.3	0.01	12.0	0	8.0
19-JUN-90	1.79	8.6	2.9	0.03	16.0	0	7.6
24-JUL-90	2.00	9.1	1.7	0.02	17.0	0	7.9
21-AUG-90	1.00	8.8	1.5	0.03	17.0	0	7.3
24-SEP-90	1.30	10.1	2.1	0.01	14.5	0	7.6
23-OCT-90	0.90	9.5	1.2	0.01	13.0	0	7.2
15-NOV-90	2.77	10.8	1.3	0.03	9.0	0	7.5
10-DEC-90	3.20	11.9	3.2	0.21	6.0	0	7.3

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
08-APR-89	2.6	12.3	1.9	0.04	11.5	0	7.7
27-APR-89	1.8	11.7	2.0	0.05	7.5	0	7.8
26-JUN-89	2.7	8.2	2.6	0.09	18.5	0	7.8
03-AUG-89	2.0	9.4	1.5	0.04	18.0	0	7.8
10-AUG-89	1.5	8.9	2.9	0.10	22.0	0	7.5
16-OCT-89	1.8	10.4	1.6	0.12	12.1	0	7.5
30-OCT-89	1.9	10.5	2.1	0.02	12.3	0	7.0
24-NOV-89	2.2	12.7	1.1	0.06	9.0	0	7.3
28-NOV-89	2.1	13.3	2.2	0.04	9.0	0	7.3
03-DEC-89	2.5	13.3	2.4	0.06	4.3	0	7.6
05-DEC-89	2.3	12.7	0.7	0.09	4.2	0	7.7
13-DEC-89	2.8	10.6	7.1	0.42	7.1	0	6.9

Ashley 1990 URN=R05E006

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-90	2.80	11.0	1.0	0.06	9.0	0	7.3
20-FEB-90	2.90	11.0	1.7	0.05	10.0	0	7.3
14-MAR-90	2.50	11.8	2.0	0.04	9.0	0	7.5
23-APR-90	2.46	13.6	2.5	0.01	12.5	0	9.0
15-MAY-90	2.50	9.1	3.0	0.03	13.0	0	7.7
19-JUN-90	2.18	9.8	2.8	0.05	17.0	0	7.8
24-JUL-90	1.90	9.2	2.3	0.03	16.0	0	7.7
21-AUG-90	1.50	8.3	1.9	0.03	17.0	0	7.4
24-SEP-90	1.30	10.0	2.1	0.03	14.0	0	7.4
23-OCT-90	1.00	10.0	0.8	0.02	13.0	0	7.3
15-NOV-90	2.24	10.6	1.7	0.03	9.0	0	7.3
10-DEC-90	3.70	11.8	3.4	0.25	6.0	0	7.4

Thorverton 1989 URN=R05D001

	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-89	2.2	12.1	2.3	0.06	5.5	0	7.5
14-FEB-89	1.7	...	...	0.09	...	0	7.6
05-APR-89	2.7	11.4	1.3	0.05	5.5	0	7.5
06-APR-89	2.8	11.6	1.7	0.03	12.0	0	7.8
11-APR-89	2.6	10.3	2.0	0.06	15.0	0	7.7
27-APR-89	2.1	11.8	1.4	0.02	8.0	0	7.8
26-JUN-89	2.4	7.6	1.7	0.03	19.0	0	7.6
30-JUN-89	2.3	8.3	2.0	0.03	16.0	0	7.4
24-JUL-89	2.4	6.6	1.9	0.06	21.0	0	7.7
03-AUG-89	2.0	9.0	1.3	0.03	19.0	0	7.8
15-AUG-89	2.2	10.3	2.5	0.02	17.0	0	8.1
04-SEP-89	2.2	9.3	3.3	0.06	14.0	0	7.7
13-SEP-89	2.5	9.8	1.7	0.14	16.0	0	7.8
19-SEP-89	1.2	10.6	1.3	0.03	17.0	0	7.3
25-SEP-89	1.5	9.5	3.4	0.01	...	0	7.6
03-OCT-89	1.7	9.2	1.6	0.02	11.5	0	7.5
09-OCT-89	2.0	9.9	2.1	0.01	12.7	0	7.5
12-OCT-89	2.3	9.4	1.1	0.07	13.4	0	7.4
16-OCT-89	1.8	10.1	1.1	0.06	13.0	0	7.4
19-OCT-89	2.2	10.1	2.7	0.02	12.7	0	7.5
27-OCT-89	1.4	10.3	0.9	0.03	12.0	0	7.3
30-OCT-89	3.1	10.0	3.3	0.10	12.4	0	7.1
10-NOV-89	3.3	10.5	0.9	0.03	10.4	0	7.1
24-NOV-89	2.6	12.8	1.5	0.06	5.0	0	7.4
01-DEC-89	2.4	12.6	2.4	0.07	3.0	0	7.7
05-DEC-89	2.8	7.5	1.4	0.08	4.6	0	7.7
06-DEC-89	2.7	12.6	2.0	0.10	9.0	0	7.7
08-DEC-89	2.7	12.6	0.7	0.09	5.5	0	7.6
12-DEC-89	2.8	11.7	2.3	0.19	5.5	0	7.8
13-DEC-89	2.2	10.8	2.5	0.26	5.9	0	7.6
14-DEC-89	4.6	10.6	6.1	0.23	8.3	0	7.3
15-DEC-89	3.8	11.9	1.9	0.07	7.6	0	7.3

Thorverton 1990 URN=R05D001

	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-90	3.40	11.0	0.9	0.06	8.7	0	7.3
17-JAN-90	2.60	11.4	1.5	0.05	8.0	0	7.3
24-JAN-90	3.10	11.0	2.6	0.05	8.0	0	7.2
15-FEB-90	9.70	11.4	1.6	0.13	6.8	0	7.4
20-FEB-90	3.90	11.1	1.5	0.05	9.5	0	7.2
05-MAR-90	4.70	11.7	1.6	0.04	9.0	0	7.4
14-MAR-90	3.30	12.0	1.9	0.05	9.0	0	7.7
23-MAR-90	2.90	12.4	1.1	0.01	9.0	0	7.8
26-APR-90	2.20	10.2	3.3	0.04	12.7	0	7.7
24-MAY-90	3.11	8.1	1.9	0.09	14.0	0	7.6
26-JUN-90	2.20	8.7	2.2	0.07	15.0	0	7.5
06-JUL-90	0.90	10.1	1.8	0.07	13.0	0	7.4
17-JUL-90	1.70	8.6	1.5	0.05	17.0	0	7.5
23-JUL-90	2.10	8.7	1.4	0.08	18.0	0	7.6
14-AUG-90	2.30	9.0	1.5	0.02	17.0	0	7.9
17-AUG-90	2.10	10.0	1.5	0.03	16.0	0	7.9
22-AUG-90	1.50	8.6	1.3	0.07	18.0	0	7.5
03-OCT-90	1.20	9.3	2.5	0.03	14.0	0	7.4
26-OCT-90	1.20	9.7	2.4	0.08	10.0	0	7.4
30-OCT-90	1.61	10.7	1.5	0.03	9.5	0	7.2
05-NOV-90	2.00	11.6	1.2	0.02	7.5	0	7.2
13-NOV-90	2.32	9.9	1.4	0.05	12.0	0	7.4
22-NOV-90	2.20	11.9	1.2	0.03	6.0	0	7.2
27-NOV-90	4.55	11.7	0.7	0.03	7.0	0	7.2
07-DEC-90	3.06	8.2	1.9	0.06	5.0	0	7.3
12-DEC-90	3.66	10.3	1.7	0.05	6.0	0	7.1

Stafford Bridge 1989 URN=R05D002

	O	Nitrate	DO	BOD	Ammonia	Temperature		ph
06-APR-89		3.9	11.1	1.9	0.07	12.0	0	7.9
27-APR-89		3.0	10.7	2.0	0.10	8.0	0	7.8
26-JUN-89		3.5	6.7	1.5	0.03	19.0	0	7.8
03-AUG-89		3.3	7.6	2.0	0.03	18.0	0	8.0
11-AUG-89		3.3	7.8	2.2	0.11	19.5	0	7.9
08-SEP-89		3.7	14.4	0.7	0.02	...	0	7.7
19-SEP-89		2.0	9.0	1.5	0.07	16.0	0	7.4

Stafford Bridge 1990 URN=R05D002

0	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-90	4.50	10.7	1.1	0.09	9.0	0	7.5
17-JAN-90	3.90	10.8	1.4	0.06	8.0	0	7.4
15-FEB-90	3.30	10.7	1.8	0.15	7.0	0	7.3
14-MAR-90	8.20	11.7	2.1	0.08	9.0	0	7.9
26-APR-90	3.60	9.4	3.3	0.04	13.2	0	7.9
24-MAY-90	4.31	9.1	2.7	0.04	14.0	0	7.7
26-JUN-90	2.90	7.0	1.7	0.04	15.0	0	7.5
14-AUG-90	3.40	7.5	1.8	0.04	17.0	0	7.7
03-OCT-90	2.20	9.2	2.2	0.03	14.0	0	7.5
05-NOV-90	2.40	11.4	1.2	0.02	7.5	0	7.2
27-NOV-90	5.88	11.1	1.3	0.05	7.0	0	7.3
12-DEC-90	5.27	11.4	2.1	0.09	6.0	0	7.4

Exwick 1989 URN-R05D003

	Nitrate	DO	BOD	Ammonia	Temperature		ph
06-APR-89	4.5	11.2	1.8	0.08	12.5	0	7.9
27-APR-89	3.4	11.3	2.2	0.07	8.0	0	7.9
26-JUN-89	3.8	7.2	1.5	0.02	19.5	0	8.0
03-AUG-89	3.3	6.3	4.3	0.41	18.5	0	7.9
11-AUG-89	3.6	8.5	2.5	0.28	19.5	0	8.0
04-SEP-89	0.5	14.0	9.4	0.01	16.0	0	8.2
19-SEP-89	2.2	9.6	1.3	0.06	16.0	0	7.5

Exwick 1990 URN=R05D003

	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-90	5.00	11.0	1.1	0.08	9.0	0	7.6
24-JAN-90	4.70	12.9	3.5	0.11	8.0	0	7.3
23-APR-90	4.59	11.9	1.8	0.03	12.2	0	8.2
09-MAY-90	4.23	8.4	2.7	0.09	13.0	0	7.7
05-JUN-90	4.50	9.7	2.0	0.04	15.0	0	7.8
08-JUN-90	3.20	12.2	3.5	0.02	15.0	0	8.4
10-JUL-90	1.90	9.9	1.2	0.04	13.0	0	7.7
30-AUG-90	3.10	9.7	1.2	0.02	18.0	0	8.0
25-SEP-90	2.50	12.1	1.8	0.04	13.5	0	8.1
23-OCT-90	2.50	9.2	0.8	0.03	13.5	0	7.6
07-NOV-90	2.80	11.1	2.0	0.04	7.0	0	7.3
13-NOV-90	4.21	9.5	2.0	0.09	12.5	0	7.4

Trows Weir 1989 URN-R05D004

	Nitrate	DO	BOD	Ammonia	Temperature		ph
12-JAN-89	3.2	11.8	2.8	0.07	5.0	0	7.6
05-APR-89	4.0	11.4	1.3	0.05	6.0	0	7.7
06-APR-89	4.3	11.5	1.9	0.08	12.5	0	8.0
11-APR-89	3.9	10.4	3.5	0.17	15.0	0	7.9
27-APR-89	3.3	11.3	1.9	0.03	8.0	0	8.0
26-JUN-89	3.4	7.8	1.9	0.08	20.0	0	8.1
30-JUN-89	3.5	8.9	1.9	0.09	17.0	0	7.8
03-AUG-89	3.0	8.2	2.0	0.10	18.0	0	8.1
10-AUG-89	2.6	7.6	3.5	0.08	21.0	0	7.9
15-AUG-89	2.7	8.5	2.3	0.09	17.0	0	8.0
04-SEP-89	3.1	9.1	1.7	0.06	16.0	0	8.0
14-SEP-89	4.2	8.2	2.3	0.18	15.0	0	7.7
19-SEP-89	2.2	9.3	1.7	0.07	16.0	0	7.5
25-SEP-89	2.7	9.5	1.4	0.03	...	0	7.9
03-OCT-89	2.7	9.7	1.1	0.04	18.0	0	7.9
09-OCT-89	3.4	10.3	1.3	0.02	13.8	0	7.9
12-OCT-89	3.6	10.0	1.2	0.04	14.5	0	7.8
16-OCT-89	3.3	10.3	1.5	0.04	14.0	0	7.8
19-OCT-89	3.6	10.5	2.0	0.03	12.5	0	7.8
27-OCT-89	2.3	10.4	1.5	0.07	13.0	0	7.4
30-OCT-89	2.0	10.2	3.0	0.04	12.0	0	6.9
10-NOV-89	6.3	10.5	2.0	0.13	10.5	0	7.2
24-NOV-89	4.3	12.3	1.3	0.10	6.5	0	7.6
30-NOV-89	4.2	12.5	1.8	0.13	2.6	0	7.6
01-DEC-89	4.1	13.3	2.5	0.10	3.5	0	7.8
04-DEC-89	4.2	11.4	2.2	0.12	4.0	0	7.9
05-DEC-89	4.7	7.8	1.8	0.08	4.6	0	7.8
06-DEC-89	4.5	12.2	2.5	0.11	9.0	0	7.8
07-DEC-89	3.6	12.1	0.8	0.11	4.9	0	7.8
08-DEC-89	4.4	12.4	0.9	0.13	5.5	0	7.8
12-DEC-89	4.4	11.0	1.6	0.10	5.5	0	7.9
13-DEC-89	4.0	10.5	2.3	0.14	5.6	0	7.9
14-DEC-89	5.8	10.3	7.9	0.51	8.4	0	7.5
15-DEC-89	7.3	10.5	3.8	0.28	8.1	0	7.3

Trews Weir 1990 URN=R05D004

	0 Nitrate	DO	BOD	Ammonia	Temperature		ph
17-JAN-90	4.70	11.0	1.4	0.07	8.5	0	7.5
24-JAN-90	4.30	11.4	3.9	0.13	9.0	0	7.4
29-JAN-90	5.60	...	1.4	0.08	0.0	0	7.3
06-FEB-90	5.70	11.2	1.2	0.07	9.0	0	7.5
20-FEB-90	5.40	11.3	2.4	0.08	9.5	0	7.5
05-MAR-90	4.80	11.7	1.7	0.05	9.0	0	7.6
07-MAR-90	5.10	11.6	1.7	0.06	8.0	0	7.7
08-MAR-90	5.10	...	2.1	0.07	0.0	0	7.7
23-APR-90	4.56	10.5	2.6	0.06	11.1	0	7.9
09-MAY-90	4.22	8.6	2.2	0.10	15.3	0	8.0
15-MAY-90	4.40	9.4	2.1	0.07	14.0	0	8.0
08-JUN-90	4.10	9.2	1.5	0.08	16.0	0	7.9
21-JUN-90	4.18	9.1	2.5	0.05	13.0	0	8.1
06-JUL-90	1.70	9.9	2.3	0.09	13.0	0	7.6
31-JUL-90	4.20	8.6	2.8	0.07	17.0	0	7.9
17-AUG-90	3.40	9.4	1.6	0.08	16.0	0	8.2
22-AUG-90	2.20	8.7	2.2	0.07	18.0	0	7.9
25-SEP-90	2.70	9.5	1.5	0.04	10.5	0	7.9
03-OCT-90	2.40	8.6	2.6	0.09	14.0	0	7.7
17-OCT-90	2.00	8.6	5.2	0.12	13.5	0	7.4
22-OCT-90	2.40	8.9	0.9	0.05	13.5	0	7.7
26-OCT-90	3.00	9.3	1.7	0.05	11.0	0	7.7
14-NOV-90	4.26	9.4	2.0	0.06	12.0	0	7.5
21-NOV-90	2.78	11.3	1.9	0.04	8.0	0	7.4
26-NOV-90	6.74	11.9	2.4	0.10	7.5	0	7.3
04-DEC-90	5.00	11.6	2.5	0.07	7.0	0	7.4
07-DEC-90	4.46	12.3	1.9	0.07	5.0	0	7.4
10-DEC-90	4.90	12.4	2.5	0.23	6.0	0	7.6