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COOTES PARADISE WATER CLARITY 1989 UPDATE

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NWRI Contribution No. 90-24

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Management Perspective

Cootes Paradise is included in the Hamilton Harbour Remedial Action Plan area. The RAP is reviewing past and present environmental conditions to determine targets, environmental stresses and options to restore beneficial uses. Cootes Paradise, a local wildlife santuary, was blessed with abundant stands of emergent and submergent vegetation prior to the 1940s. Several environmental stresses, most notable of which is high water turbidity have resulted in the lost of virtually all of the vegetation. The easiest problem to control was the sewage discharge from the town of Dundas and so since the 1970s various improvements at the sewage treatment plant (STP) have been implemented. In 1988, sand filters were installed which reduced the phosphorus and suspended solids loading. No further improvements at the STP are possible except for complete removal of the discharge into Cootes Paradise. The other environmental stresses such as soil erosion on the Spencer Creek watershed, resuspension within Cootes Paradise and carp activity are either not controllable or in the case of soil erosion, only small reductions appear possible and will take 20-40 years to implement. Therefore, the 1988 reduction of loading from the STP was the only action in the foreseeable future that promised to improve water clarity in Cootes Paradise.

Water clarity was not improved in 1989 compared to previous years. Seston and chlorophyll concentrations were not reduced compared to previous years. A small improvement in water clarity occurred in Cootes Paradise during a short drought which confirmed the earlier findings that water clarity in Cootes Paradise was dominated by silt originating from Spencer Creek and from resuspension activities of carp.

Restoration of vegetation in Cootes Paradise is unlikely to occur unless more direct measures are undertaken to decrease silt loads from Spencer Creek, eliminate the effects of resuspension by wind, waves and carp and isolate the marsh from the high nutrient loading from the STP or relocate the STP discharge.

Perspective-gestion

Cootes Paradise est compris dans la zone du plan de mesures correctives (PMC) pour le port de Hamilton. Le PMC étudie les conditions passées et présentes du milieu pour déterminer les cibles, les stress environnementaux et les options qui permettront de profiter à nouveau des avantages de cette réserve de faune régionale. Avant les années 1940, Cootes Paradise était dotée d'une végétation émergente et partiellement submergée abondante. Plusieurs stress environnementaux, dont notamment la turbidité élevée de l'eau, ont causé la perte de pratiquement toute la végétation. Le problème le plus facile à traiter à été l'évacuation des eaux usées de la ville de Dundas et, depuis les années 1970, diverses améliorations ont été apportées à l'usine de traitement des eaux usées (UTE). En 1988, on a installé des filtres à gravier qui ont réduit l'apport de phosphore et de matières en suspension. L'UTE ne peut plus être améliorée, mais on pourrait cesser complètement d'évacuer les eaux usées dans Cootes Paradise. On ne peut rien faire contre les autres stress environnementaux, comme l'érosion du sol dans le bassin hydrographique de Spencer Creek, la remise en suspension dans Cootes Paradise et l'activité des carpes, sauf peut-être contre l'érosion du sol qu'on pourra freiner un peu, mais sur une période de 20 à 40. Par conséquent, la réduction de l'effluent de l'UTE en 1988 était la seule mesure qui puisse rendre l'eau de Cootes Paradise plus limpide dans un avenir prévisible.

L'eau n'était pas plus limpide en 1989, comparativement aux années précédentes. Les concentrations de seston et de chlorophylle n'ont pas été réduites. On a observé une légère amélioration de la limpidité de l'eau dans Cootes Paradise au court d'une courte période de sécheresse, ce qui a confirmé des données obtenues auparavant qui indiquent que la limpidité de l'eau dans Cootes Paradise est surtout influencée par la vase provenant de Spencer Creek et par la remise en suspension des sédiments par les carpes.

Il est improbable que la végétation revienne dans Cootes Paradise, à moins de prendre des mesures plus directes pour diminuer la quantité de vase provenant de Spencer Creek, d'éliminer les effets de la remise en suspension par le vent, les vagues et les carpes et d'isoler le marais des charges élevées d'éléments nutritifs provenant de l'UTE ou de relocaliser le point d'évacuation de l'UTE.

ABSTRACT

Painter and McCabe (1988) examined the water clarity problem in Cootes Paradise and concluded that several actions would be necessary to improve water clarity and reduced loading from the Dundas STP was one of the recommendations. In 1988, the Dundas Sewage Treatment Plant (STP) reduced its phosphorus and suspended solids loading to Cootes Paradise by installing sand filters. Cootes Paradise was revisited in 1989 to determine if water clarity had improved. Secchi disc transparency, seston, and chlorophyll at the main open water station and at West Pond, the direct recipient of the STP effluent, were no different from past years. Water clarity appears to be more a function of incoming turbidity on Spencer Creek and resuspension processes in Cootes Paradise than algae stimulated by phosphorus loading from the STP.

RÉSUMÉ

Painter et McCabe (1988) ont étudié le problème de turbidité de l'eau de Cootes Paradise et sont arrivés à la conclusion que plusieurs mesures seraient nécessaires pour rendre l'eau plus claire; ils ont recommandé, entre autres, la réduction de l'effluent de l'usine de traitement des eaux usées (UTE) de Dundas. En 1988, l'UTE de Dundas a réduit les quantités de phosphore et de matières en suspension déversées dans Cootes Paradise en installant des filtres de sable. Les auteurs sont retournés à Cootes Paradise en 1989 pour vérifier si l'eau était devenue plus claire. La transparence mesurée au disque de Secchi, le seston et la chlorophylle à la station principale en zone d'eau libre et à West Pond, l'endroit où est rejeté directement l'effluent de l'UTE, étaient du même ordre que les valeurs mesurées les années précédentes. La limpidité de l'eau semble dépendre davantage de la turbidité provenant de Spencer Creek et des processus de remise en suspension dans Cootes Paradise que de la stimulation de la croissance des algues par les quantités élevées de phosphore provenant de l'UTE

INTRODUCTION

Cootes Paradise has lost approximately 85% of its marsh habitat (Painter and McCabe, 1988). Poor water clarity is the major factor accountable for the loss of aquatic plants. Both urban and agricultural development and the discharge of the Dundas Sewage Treatment Plant (STP) contribute to the poor water clarity. The resuspension of sediment by carp, wind and wave action is also important. The Preferred Options Report of the Hamilton Harbour Remedial Action Plan has identified the restoration of marsh habitat in Cootes Paradise as a high priority. Corrective measures for achieving and maintaining submergent plant habitat have been recommended by Painter and McCabe (1988) and include:

- 50% seston and 60% phosphorus loading reductions from the watershed;
- elimination of sediment resuspension by wind and wave action to maintain seston concentrations at 10-15 mg/L;
- phosphorus loading reductions from the Dundas Sewage Treatment Plant (STP) and Hamilton Harbour and combined sewer overflows sufficient to reduce phosphorus concentrations by 65%;
- carp control to reduce vegetative destruction and their effects on water clarity; and
- dredging of the nutrient-rich sediment.

Cootes Paradise receives two major inputs - the Dundas STP and Spencer Creek. Semkin et al. (1976) determined that the Dundas STP was the more significant source of total and soluble phosphorus, whereas Spencer Creek was the predominant source of suspended solids. The Dundas STP installed sand filters in July 1988 which reduced its phosphorus loading into Cootes Paradise from 5.6 kg/day to 3.4 kg/day and its suspended solids loading from 56.8 kg/day to 25 kg/day. This report examines the water clarity data collected from Cootes Paradise between 1977 and 1989 to determine if any improvements in water clarity occurred as a result of the Dundas STP loading reduction.

METHODS

Water samples were collected at fifteen locations at weekly intervals between April 8 and November 3, 1987; at bi-weekly intervals between May 2 and October 19, 1988; and at weekly intervals between May 4 and September 28, 1989. The sampling locations, the Dundas STP and Spencer Creek, are illustrated in Figure 1. The sampling locations were chosen to elucidate the factors responsible for the spatial variability in water clarity and the effect of inputs from the Dundas STP and Spencer Creek.

At each sampling location, Secchi disc transparency and vertical extinction coefficients were measured. The vertical extinction coefficients were determined with a Biospherical Instrument Profiling Quantum Scalar Irradiance system with quantum response in the range of 400 to 700 nm. The downwelling irradiance was measured at 10 cm intervals.

Composite water samples for chlorophyll a analyses were collected through a depth equal to twice the Secchi disc transparency to approximate the depth of the euphotic zone. Aliquots (0.2-1.0 L) were filtered through GF/F glass-fibre filters (Whatman Co.), frozen, and analyzed later using the methods employed by the Water Quality Branch, Environment Canada (see Environment Canada, 1979). The calculated chlorophyll concentration uncorrected for phaeophytin was used to assess the relative contribution of algae to the Secchi disc transparency because it takes into account that living as well as dead or decaying algal cells contribute to the water clarity. Seston and mineral concentrations were measured by filtering known volumes of water through Whatman GF/C filter papers. The mineral content was determined by muffling the total seston at 550°C for two hours.

Nutrient and Secchi disc transparency data from 1977 to 1989 has been collected bi-weekly by the Royal Botanical Gardens staff biologist, Mr. Len Simser, at the six main stations. The water samples were submitted to the Regional Municipality of Hamilton Laboratory for analysis.

RESULTS

Station CP1 is located in the open water area of Cootes Paradise. Another station (CP2) is also located in the open water area but for the purposes of this report and to simplify the discussion, CP1 observations only will be used to determine the response of the open water area of Cootes Paradise to the Dundas STP loading reductions. Station CP5 is located in West Pond and is the direct recipient of the Dundas STP effluent and therefore water quality conditions within West Pond may be influenced more directly by the Dundas STP improvements.

Stations CP1 and CP5 nutrient and Secchi disc transparency means gathered from 1977 to 1989 have been summarized in Table 1. No discernable improvement in phosphorus and chlorophyll at these two stations is apparent. Figures 2 and 3 illustrate the three-year seasonal trend for total and soluble phosphorus at CP1 and CP5 and again no reduction is apparent. Figures 4 and 5 illustrate the seasonal trend in chlorophyll concentrations at the two stations for 1987 and 1989 and again no apparent reduction is discernable.

Secchi disc transparency measurements have been collected at CP1 on an annual basis since 1977 (Table 1). Water clarity in 1989 was similar to previous years when nutrient loading from the Dundas STP was much higher (45 kg/day). The improvements at the Dundas STP appear not to have improved water clarity at station CP1.

When examining the seasonal fluctuation in water clarity between 1987 and 1989, station CP1 Secchi disc transparency was similar except during the July 4 to August 13 period in 1989 when a 15-cm improvement was observed (Figure 6). Seston concentrations at CP1 for the two years confirm the Secchi disc transparency results (Figure 7).

If the Dundas STP improvements in 1988 had had an impact, an improvement would have been expected in chlorophyll and seston during the majority of the season. The fact that the water clarity difference between the two years is isolated to a specific time period would suggest that another factor(s) is responsible.

Rainfall patterns between the two years and hence suspended solids concentrations in Spencer Creek may be responsible. An average of 4.19 mm of rain fell during the 1987 July 4 to August 13 period, whereas an average of only 1.27 mm fell during the 1989 period. Suspended solids concentrations taken at the upstream Spencer Creek station (CP4B) averaged 27 mg/L and 7 mg/L in 1987 and 1989, respectively (Figure 8). It appears that the lack of rain during July and August, 1989 resulted in lower suspended solids concentrations flowing into Cootes Paradise from Spencer Creek and an improvement in water clarity during that time period.

A similar drought occurred in 1988 from mid-May to mid-July. An average of 0.55 mm of rainfall was recorded during this period, however, the average suspended solids concentration in the Spencer Creek inflow during the 1988 drought was 22 mg/L. Unlike the mid-summer 1989 drought, lower suspended solids concentrations in Spencer Creek were not observed during the late spring drought in 1988. Carp spawning activity is intense during the months of May and June, leading to the resuspension of sediments. In July, carp activity subsides and effects upon water clarity are now primarily a result of feeding habits. The different time periods of the low rainfall events in 1988 compared to 1989 and the intense activity of carp during the 1988 drought may explain the differences in seston responses between the two droughts.

Secchi disc transparency measurements have been collected at CP5 on an annual basis since 1977 (Table 1). Water clarity in 1989 was similar to previous years when nutrient loading from the Dundas STP was much higher (45 kg/day). Again, it appears that the Dundas STP improvements have not improved water clarity at station CP5. This station is the direct recipient of the Dundas STP and receives no other input. The chlorophyll concentrations at CP5 were not significantly different (Figure 5). Seston concentrations at CP5 fell from an average 105 mg/L in 1987 to 90 mg/L in 1989. The high seston concentrations in West Pond are not due to high seston concentrations in the STP effluent. The seston concentrations in the effluent are approximately 1 mg/L compared to the 90 mg/L seston concentrations at CP5. The high seston concentrations must be due to resuspension of sediments by carp and the high algal biomass.

The Dundas STP discharged 25 kg/day of suspended solids on average during 1989, as opposed to Spencer Creek's discharge of approximately 1200 kg/day. When the suspended solids loading of Spencer Creek is compared to the remainder of Cootes Paradise, the loading from Dundas STP is minor. Suspended solids loading reductions at the STP would be expected to have a minor or negligible impact on water clarity in Cootes Paradise.

In 1975, the phosphorus loading from the Dundas STP was estimated to be approximately six times greater than the summer loading from Spencer Creek (Semkin et al., 1976). Assuming that the Spencer Creek loading has remained the same, the improvements at the Dundas STP would now reduce the relative importance of the STP to less than half that of Spencer Creek. Silt dominates the water turbidity problem in the open water area of Cootes Paradise (Painter and McCabe, 1988) and could explain why the improvements at the STP appear to have had a negligible effect on water clarity. The water clarity improvements observed in the open water area of Cootes Paradise during July and early August, 1989 would appear to be due to the low precipitation and suspended solids concentration in Spencer Creek.

REFERENCES

Environment Canada. 1979. Analytical Methods Manual. Inland Waters Directorate, Water Quality Branch, Ottawa, Ont.

Semkin, R.G., A.W. McLarty, and D. Craig. 1976. A Water Quality Study of Cootes Paradise. Ontario Ministry of Environment, West Central Region.

Painter, D.S. and K.J. McCabe. 1988. Water Clarity in Hamilton Harbour. National Water Research Institute Contribution No. 89-31.

Table 1: Cootes Paradise 1977 to 1989 Stations CP1 and CP5 Means

Stn	Year	Secchi (cm)	Chl (μg/L)	Tot Ph (μg/L)	Sol Ph (μg/L)
CP1	1977	17.4	82.78	239.00	25.20
CP1	1978	27.5	110.25	153.82	8.86
CP1	1979	23.8	90.16	187.73	13.91
CP1	1980	26.4	134.57	124.73	8.15
CP1	1981	16.7	80.52	165.00	28.22
CP1	1982	19.4	116.19	120.73	59.00
CP1	1983	21.2	105.48	144.45	17.73
CP1	1984		68.08		
CP1	1985		71.60		
CP1	1986	17.3	33.28	157.14	32.86
CP1	1987	18.4	87.19	170.00	30.00
CP1	1988	20.0	22.21	260.83	65.83
CP1	1989	21.5	67.30	220.00	50.00
CP5	1977		103.86	268.00	162.30
CP5	1978		162.27	131.18	35.31
CP5	1979	19.0	230.76	400.27	47.40
CP5	1980	17.8	212.29	357.18	20.69
CP5	1981	15.6	187.57	158.20	22.20
CP5	1982	14.8	192.93	105.55	60.09
CP5	1983	16.0	241.16	536.27	30.73
CP5	1984		123.87		
CP5	1985		150.38		
CP5	1986	17.5	93.53	318.57	65.71
CP5	1987	15.4	127.83	414.29	74.29
CP5	1988	16.8	43.83	690.83	154.17
CP5	1989	17.0	102.92	422.50	111.25

Figure 1: Cootes Paradise Study Area

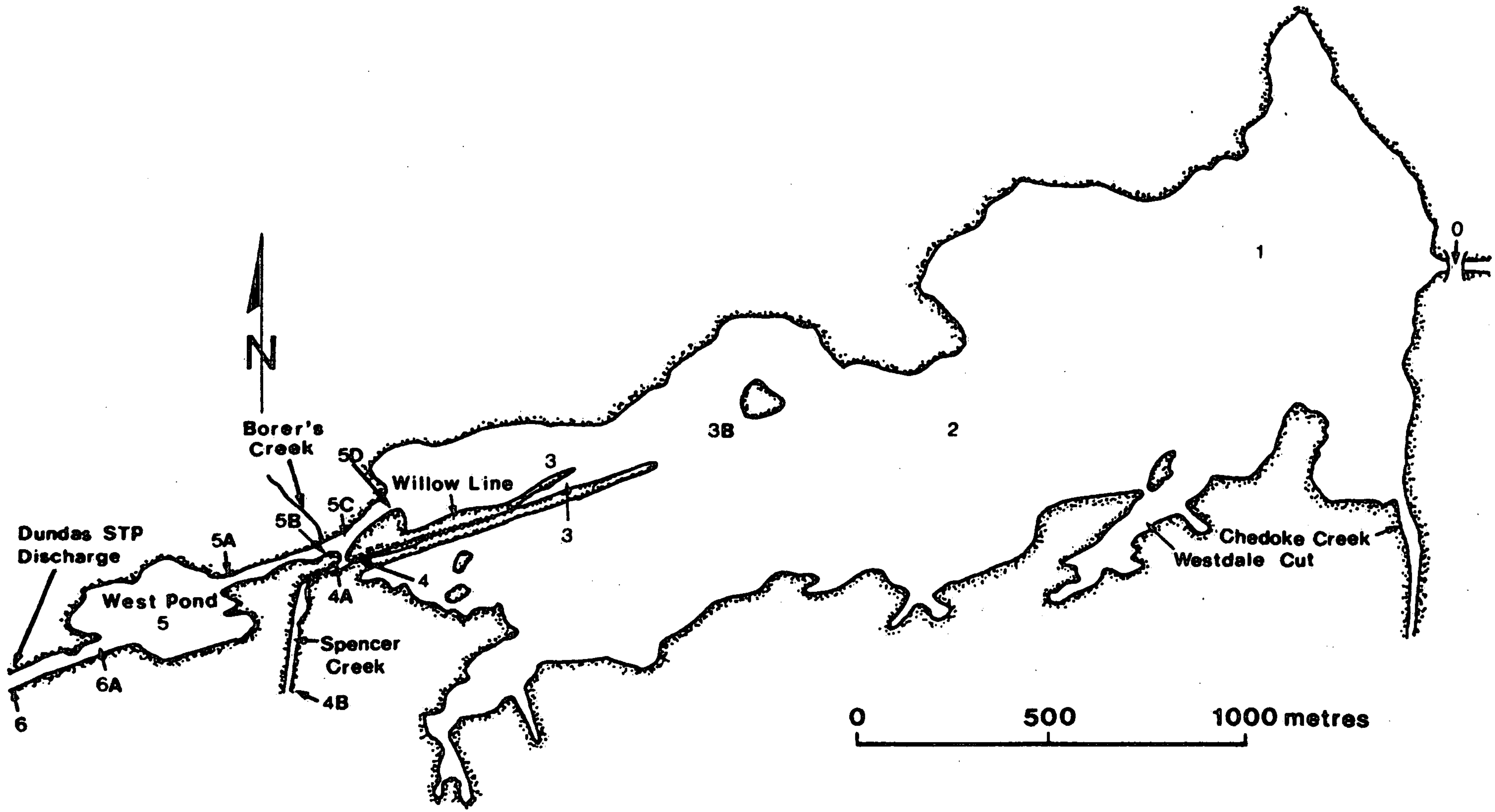


Figure 2: 1987, 1988, and 1989 Total and Soluble Phosphorus at CP1

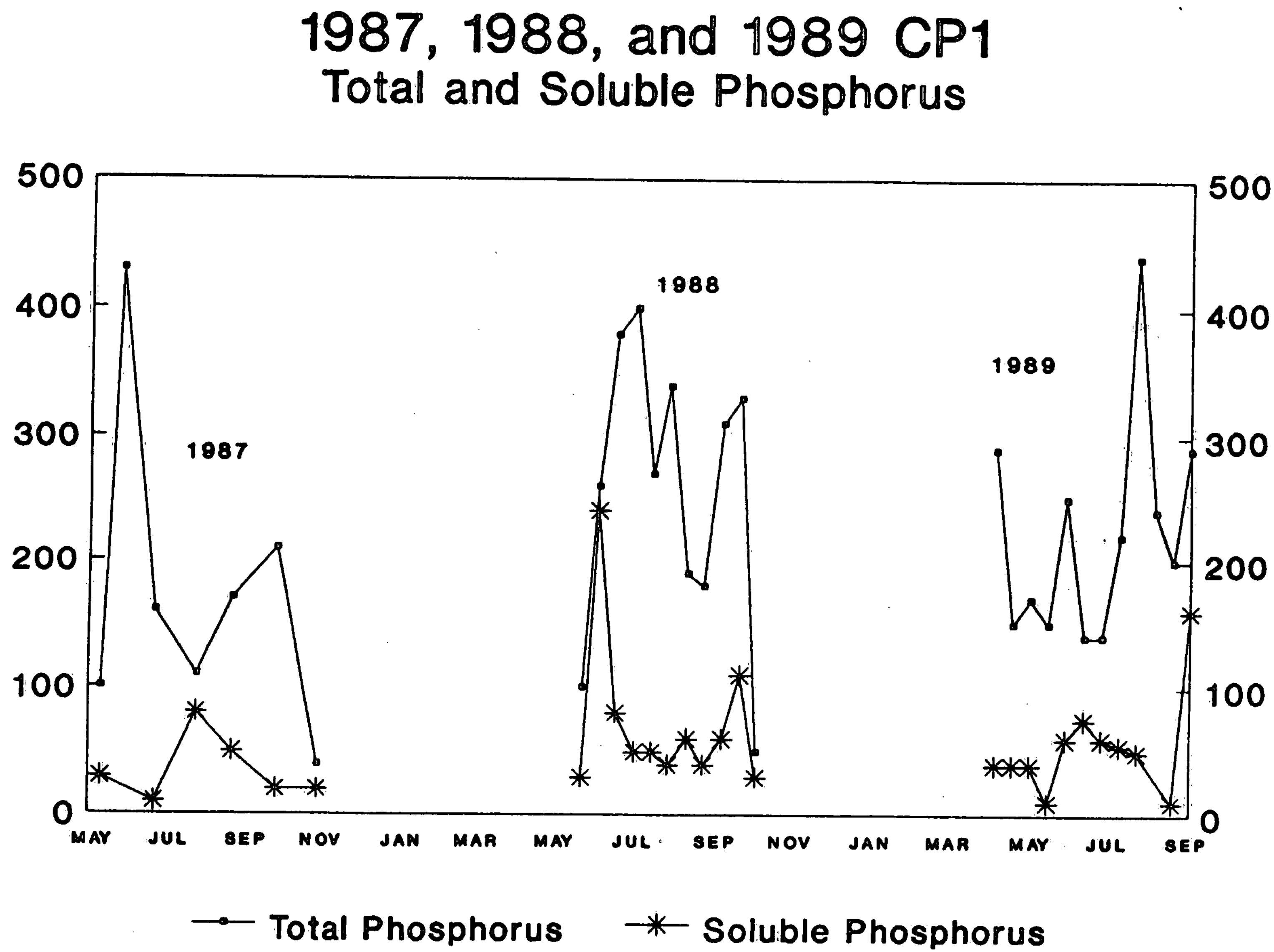


Figure 3: 1987, 1988, and 1989 Total and Soluble Phosphorus at CP5

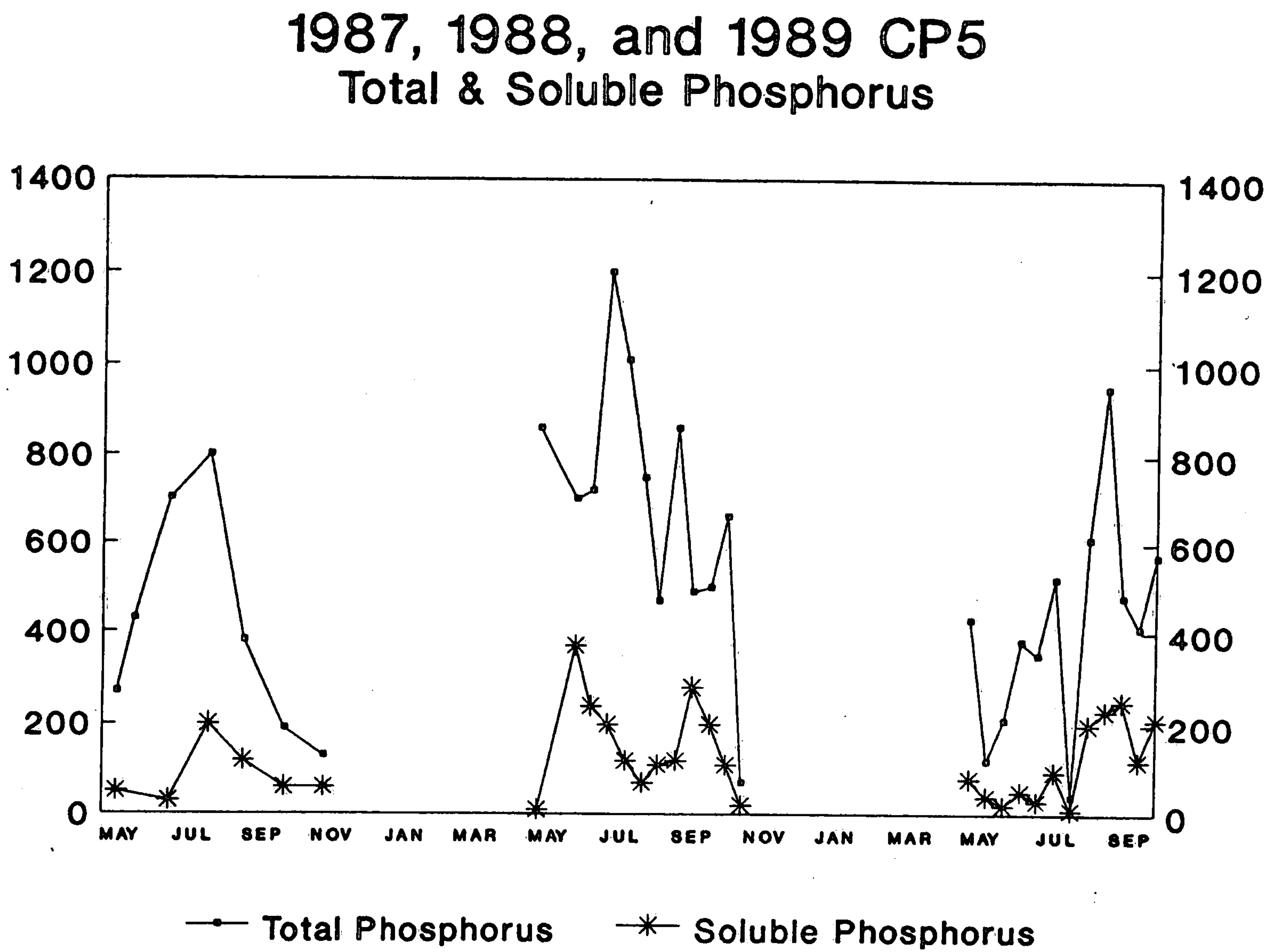


Figure 4: 1987 and 1989 Chlorophyll a - CP1

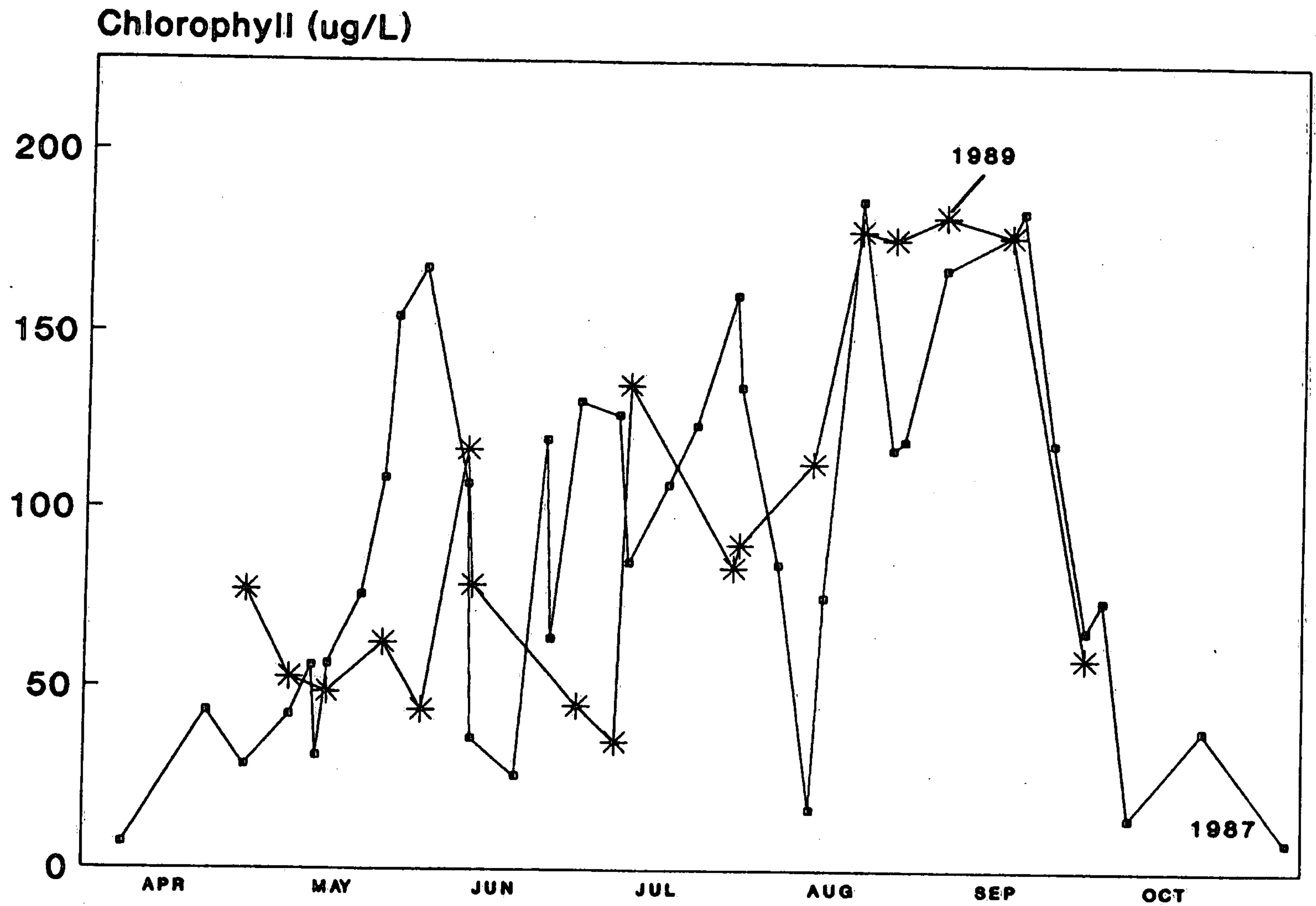


Figure 5: 1987 and 1989 Chlorophyll a - CP5

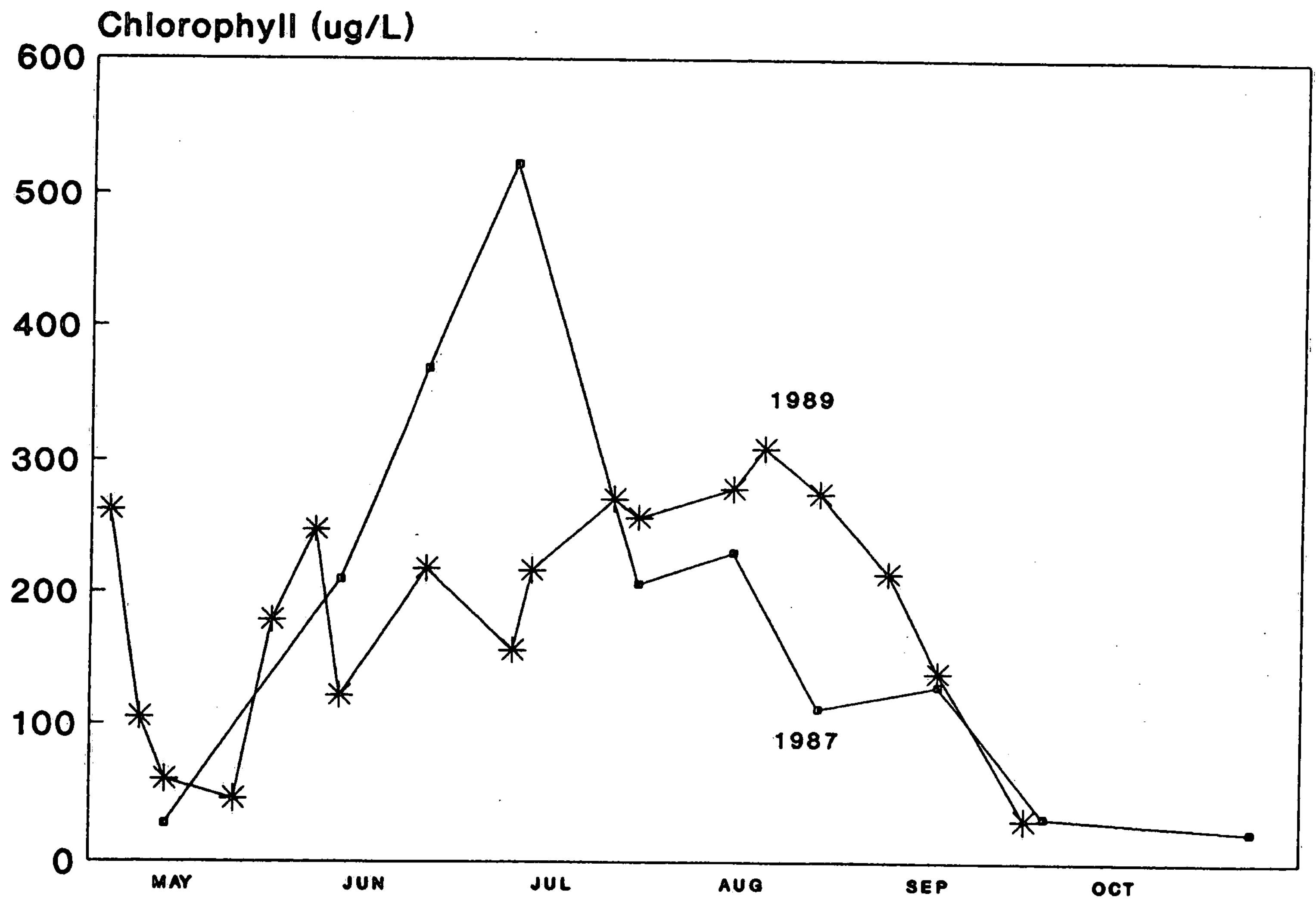


Figure 6:

1987 and 1989 Secchi - CP1

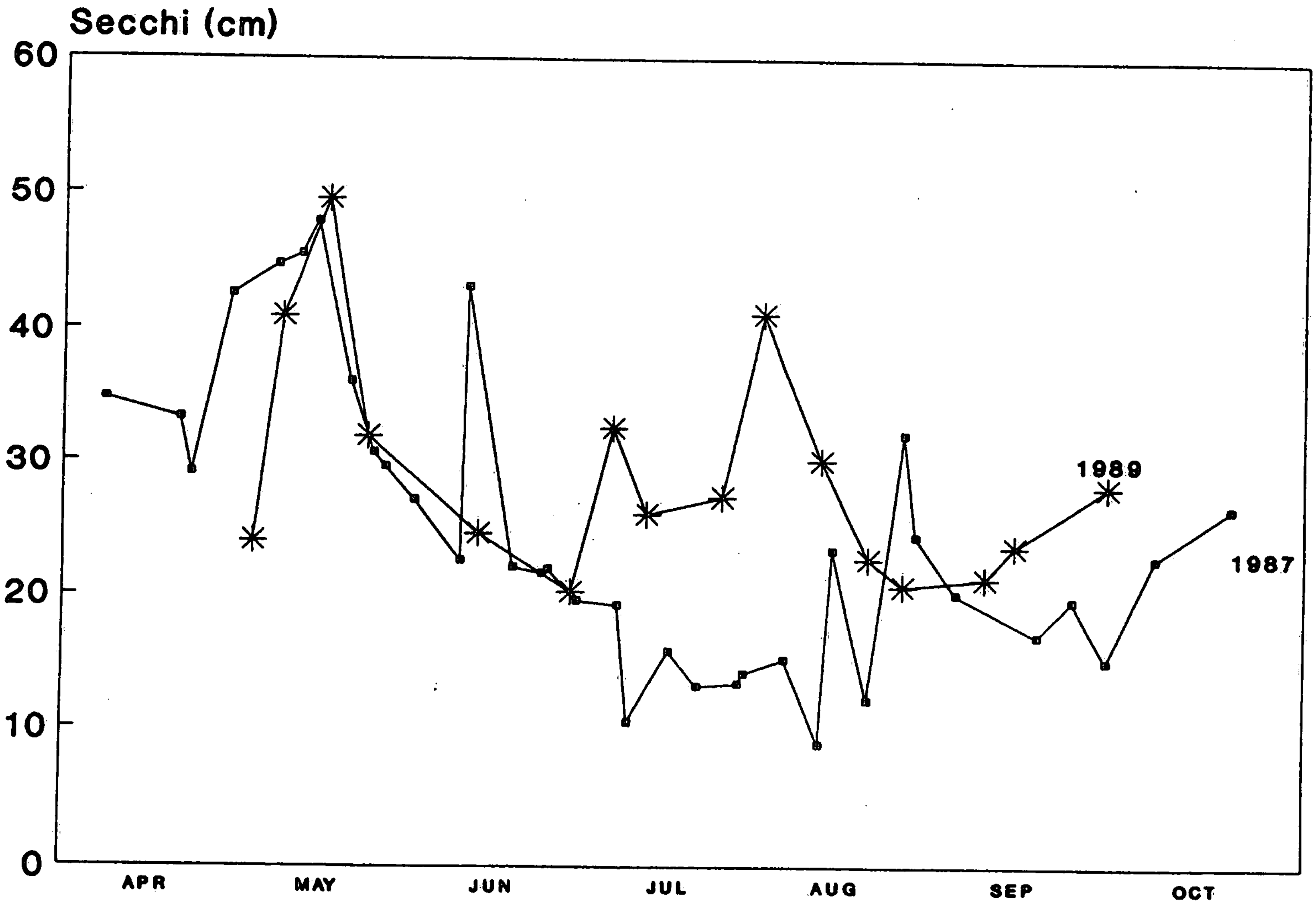


Figure 7:

1987 and 1989 Seston - CP1

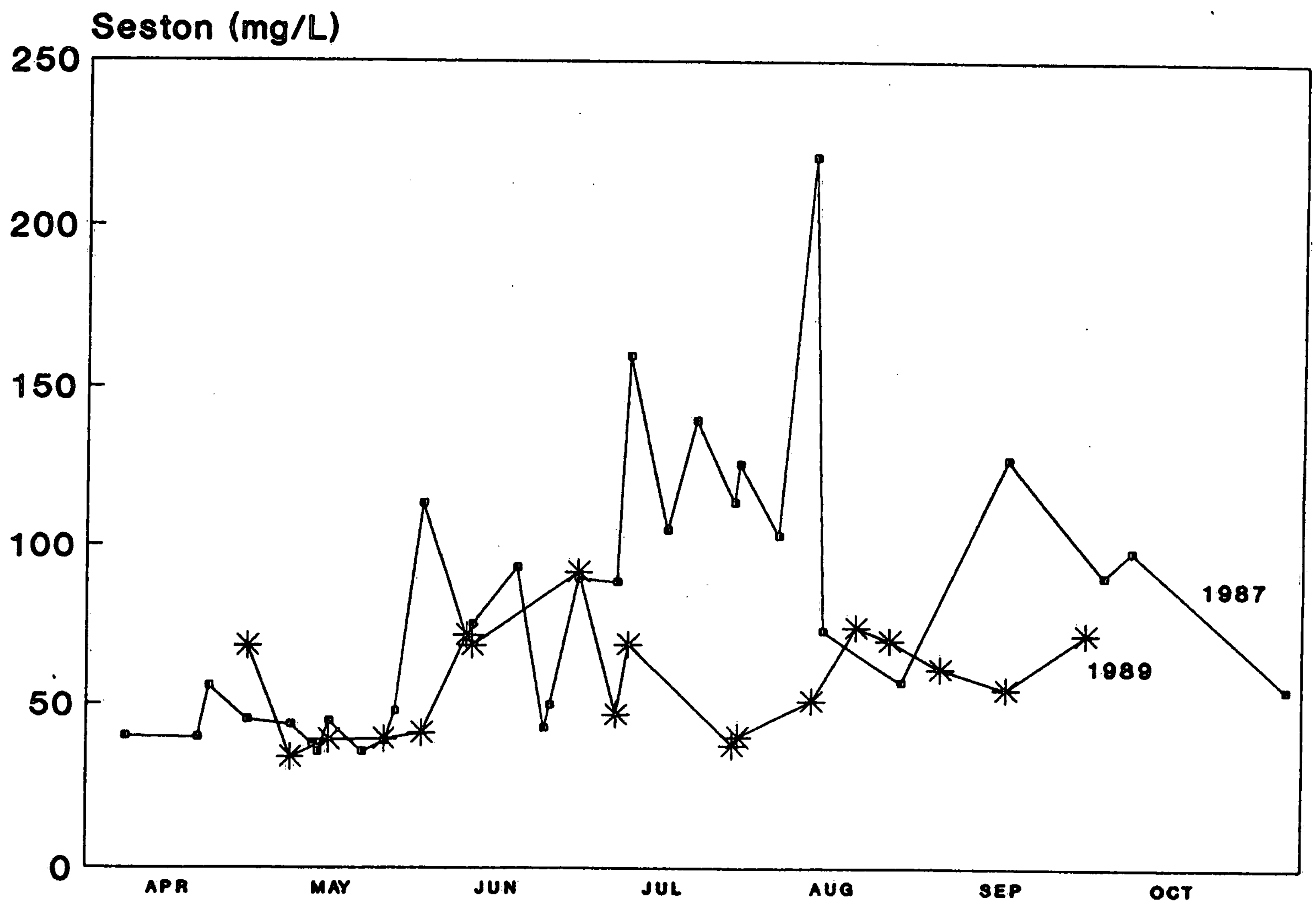


Figure 8:

Spencer Creek S.S. Conc. (mg/L) for 1987, 1988, and 1989

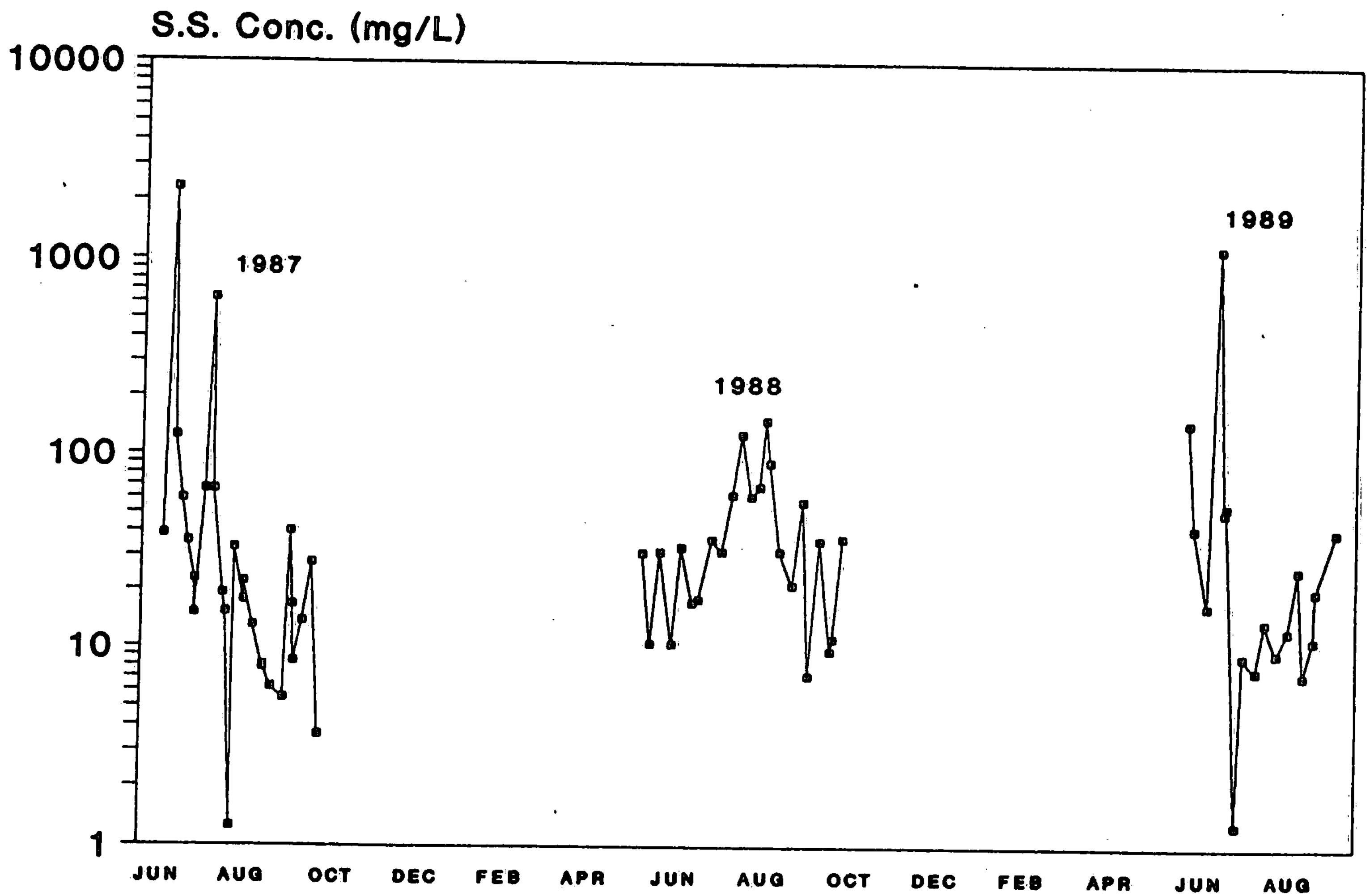
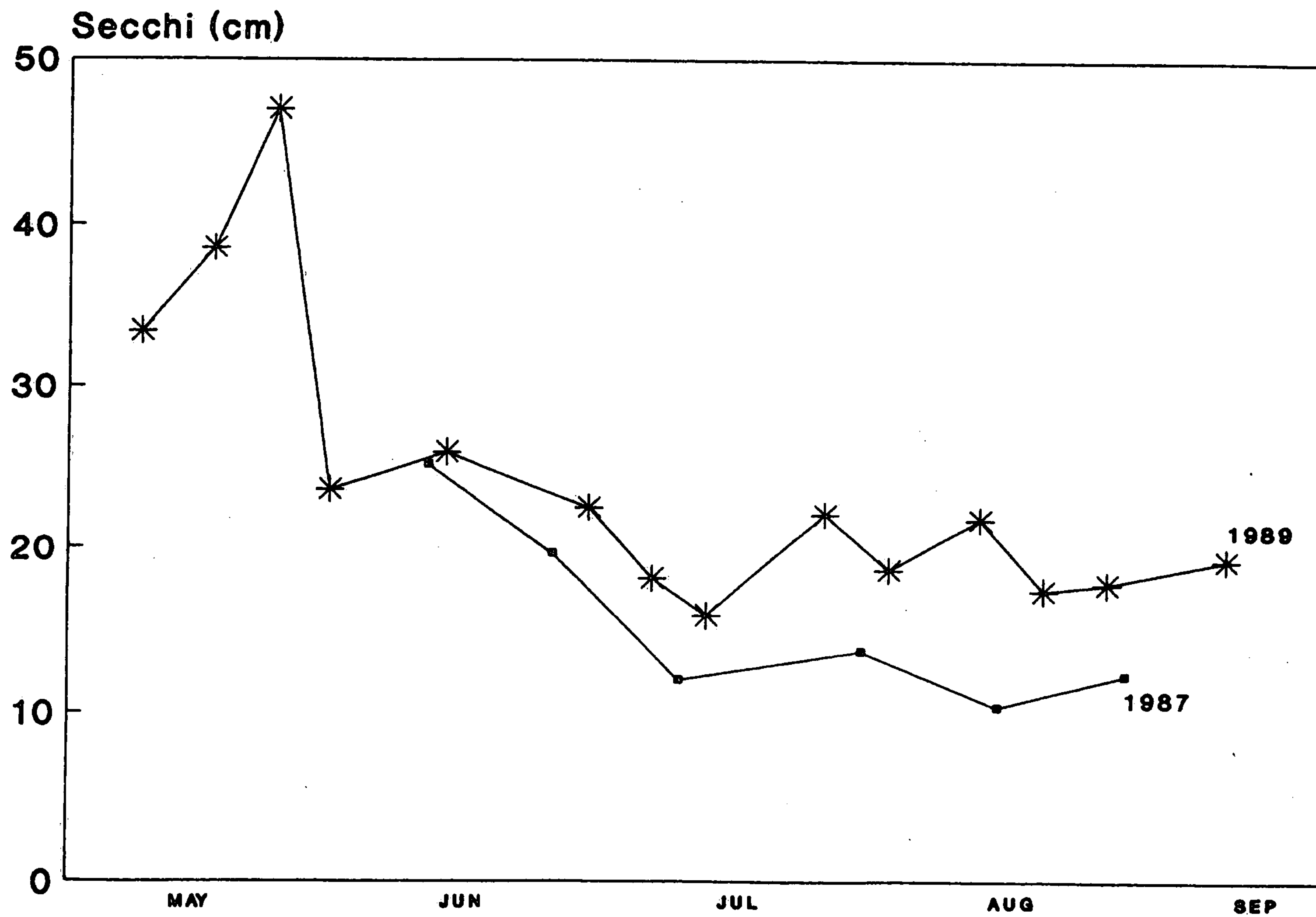


Figure 9:

1987 and 1989 Secchi - CP5



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