Contents

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1. Introduction

This report provides a review of the surface water salinity data collected at three sites in the Ovens Basin for the 1999 calendar year. A brief analysis of the data is also included.

This report contains :

- An assessment of the usefulness and accuracy of information provided by the monitoring sites, with recommendations where appropriate.
- A schedule of missing data for all sites.
- Basic flow, salinity and salt load statistics for selected sites.
- Time series graphs for flow and salinity for each site.
- An evaluation of graphs and statistics for possible faulty data.
- A brief assessment of catchment characteristics and implications for Murray Darling Basin Salinity Strategy.

This brief annual review is essential to ensure the integrity of the monitoring program, and is a precursor to any full analysis of data from these monitoring sites. In addition, it will provide a simple indicator for the impact of salinity both within the region and in the wider context of the Murray Darling Basin.

2. Catchment Description

The three continuous flow and salinity monitoring sites that have been reviewed in this report are located in the lower portion of the Ovens catchments as shown in Figure 2.1. The total catchment covers approximately 36,500ha and is recognised as contributing approximately 14% of the total volume of water to the Murray Darling Basin system (NESWG, 1997). Dryland salinity due to rising water tables in the floodplains is a recognised factor in the decline of water quality in the lower part of catchment, particularly to the foothills regions.

2.1 Ovens River

The Ovens River drains from the northern side of the Great Dividing Range and discharges to the River Murray upstream of Yarrawonga. The Ovens River monitoring site that is being assessed in this report is located at Peechelba. This site is being used by the Murray Darling Basin Commission for spot flow measurements and flood forecasting. There are a number of anabranches at this site and obtaining a rating is complex. However, Thiess have indicated that it is possible to develop a rating at this site (pers. comm. Bill Mitchell, 11/6/99).

It should be noted that although there is also a flow monitoring site upstream of Peechelba at Wangaratta (Site 403242) the site does not capture any flows from the Fifteen Mile Creek system which flows into the Ovens River downstream of Wangaratta (Refer to Figure 2.1). The Peechelba site was chosen to best represent the salt load reaching the Murray River from the entire Ovens catchment.

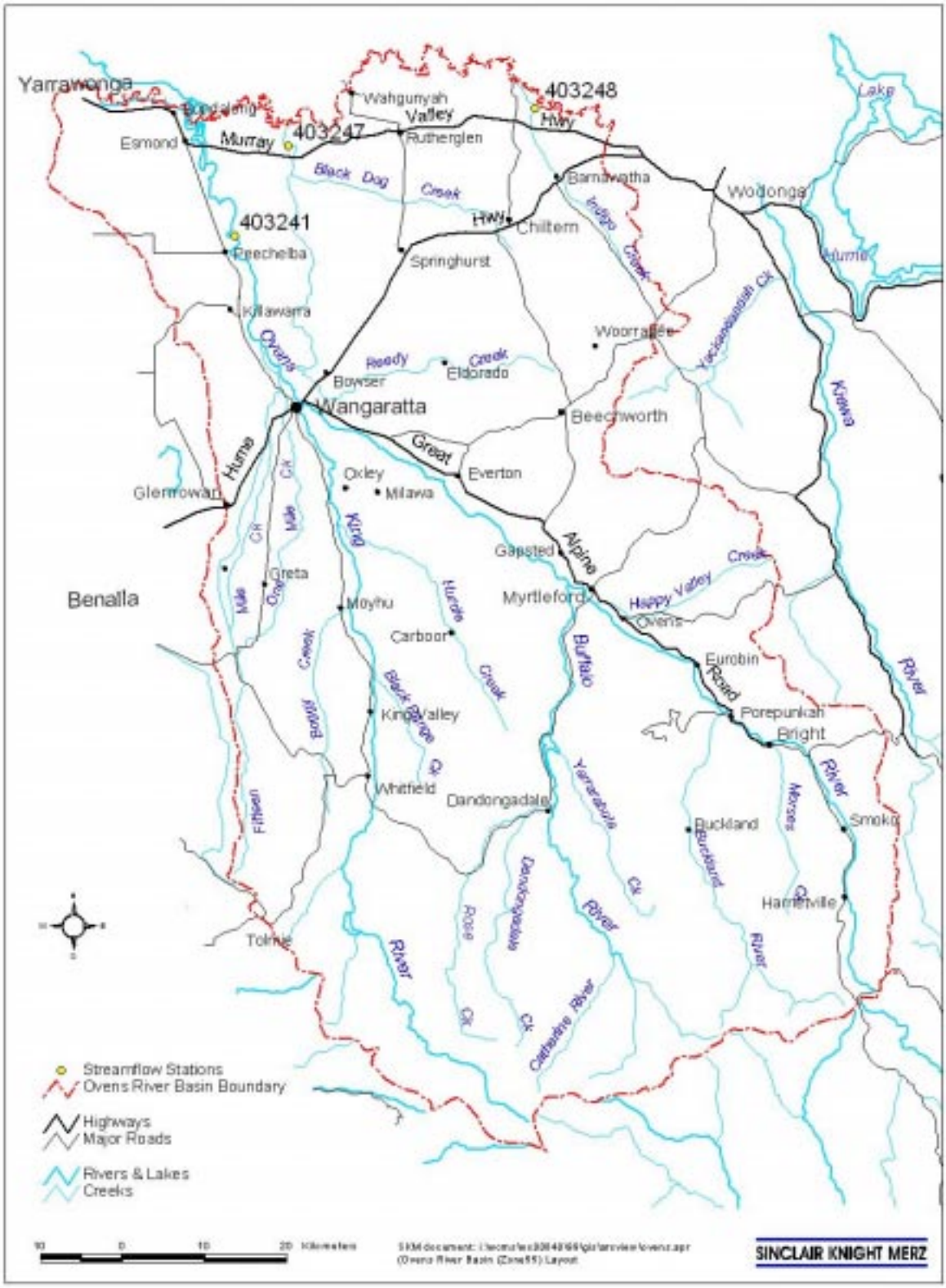
2.2 Black Dog Creek

Black Dog Creek originates near Chiltern and flows across the Riverine Plains to the Murray River. The catchment is mainly cleared and although there is some steeper terrain in the upper reaches, the significant land management unit is Riverine Plain Upper Terrace. The catchment includes a large area on the Riverine Plain near Wangaratta where surface water can pond and will not necessarily always drain to the Black Dog Creek system. There are a significant number of noted discharge sites in the catchment (NESWG, 1997), particularly in the Springhurst Hills area.

2.3 Indigo Creek

The Indigo Creek originates amongst some steep terrain north of Yackandandah and flows across the Riverine Plain Upper Terrace to the River Murray. The catchment is mainly cleared and has been identified as having a significant number of discharge sites (NESWG, 1997). The discharge sites are concentrated in the middle reaches of the catchment where there is a transition from the steeper terrain to the Riverine Plains.

Figure 2.1: Locality Map of Monitoring Sites



3. Data Assessment

3.1 Data Available

Report covers three continuous monitoring sites

This report covers three hydrographic monitoring sites, as listed in Table 3.1 below. The table shows the total extent of data available at the sites. The North-East data collection program began in the latter part of 1998 and all data has been examined for completeness and integrity.

Table 3.1: Data Available

Station	Number	Parameter	Frequency	Start Date	End Date
Ovens River @ Peechelba	403241	Flow	Continuous	22/9/1998	Ongoing
		Salinity	Continuous	22/9/1998	Ongoing
Black Dog Creek @ Parris Road, Brimin	403247	Flow	Continuous	22/8/1998	Ongoing
		Salinity	Continuous	22/8/1998	Ongoing
Indigo Creek	403248	Flow	Continuous	24/6/1999	Ongoing
		Salinity	Continuous	24/6/1999	Ongoing

3.2 Proposed Monitoring

One of the recommendations of the Draft North East Salinity Strategy (NESWG, 1997) was that new flow and water quality monitoring sites should be established at a number of nominated locations within the Ovens Basin. The final two locations nominated for monitoring, which have not yet been established, are the Buffalo River near the Ovens River junction and Fifteen Mile Creek near its outfall to the Ovens River. It was also recommended that water quality monitoring should be re-established on the Ovens River at Wangaratta and Reedy Creek in Wangaratta North. These are yet to be established although flow is currently monitored at these two sites. In addition to these sites, it should also be noted that a fourth monitoring site, to be reviewed as part of this program in the year 2000, was established during 1999 on the Three Mile Creek near Wangaratta.

Funding is yet to be made available for nutrient monitoring at any of the existing monitoring sites.

3.3 Current Data Collation

Overall the data collected during 1999 was of excellent quality.

There were only twenty six days for which the quality code was higher than three for the periods examined, ending 31/12/1999 (see Table 3.1). Full details of missing data have been included in Appendix B and details of estimated data with an explanation of quality codes is included in Appendix C.

A summary of data collection is presented below.

Capture of flow data was excellent with only twenty five days missing for the Indigo Creek gauge. Each of the days of missing data was coded 150, which indicates that the rating has been extrapolated due to insufficient gaugings. Although the flow has been estimated, use of this figure in any detailed studies should be treated with caution. This missing data code is to be expected with new sites as flows beyond the range of the available rating occur. The accuracy of high flow data is expected to improve with additional stages measured by Thiess.

Capture of salinity data was also excellent with one day being missed by the Black Dog Creek probe. This gap was attributed to the salinity probe not registering and was most likely caused by the probe being dry after an extended period of no flow.

4. Flow and Salinity Statistics

4.1 Statistics explained

The statistical analysis is based on available raw data listed in Table 3.1. Table 4.1 (flow) and Table 4.2 (salinity) present the following flow and salinity statistics for 1999:

MEAN DAILY - the average value of all measurements on a specified day.

MEDIAN - the value above (or below) which half the data set falls. The median gives an indication of the 'most usual' flow or salinity in the stream.

UPPER QUARTILE - the value below which three quarters of the data set falls, giving an indication of how high the flow and salinity can ordinarily get without being influenced by extreme events.

LOWER QUARTILE - the value below which one quarter of the data set falls, giving an indication of how low the flow and salinity ordinarily falls without being influenced by extreme events.

MAXIMUM - the highest value recorded. It is generally not a good indication of the flow or salinity of the stream because such a high value may be rare. However it is sometimes useful to be aware of extreme values, and the maximum may highlight uncharacteristic behaviour that contributes to high flow and salinity.

MINIMUM - the lowest value recorded. It is generally not a good indication of the flow or salinity of the stream because such a low value may be rare or is zero on one or a number of days.

SALT LOADS – a measure of the total quantity of salt transported by a stream, measured in tonnes/day. The figures quoted in this report are mean daily values which have been calculated by averaging the instantaneous salt loads throughout the day. The instantaneous salt load is calculated as follows:

Salt Load = Flow (ML/day) x EC (µs/cm) x (0.6/1000)

FLOW WEIGHTED SALINITY (FWS) - a measure of the salinity of water during flow events. This measure is of particular relevance to downstream interests. In many Australian streams the salinity during average to high flow events is much lower than the salinity during low flow periods. The FWS is derived by dividing the salt load for a study period by the total flow for the same period (which produces a salinity in tonnes/megalitre) then dividing by 0.0006 to express the result in the more familiar EC units.

4.2 Flow Statistics

The key flow statistics as described in the previous section are presented below in Table 4.1. All flows are quoted in ML/day. Time series plots of the raw flow data are included in Appendix A.

Table 4.1: Statistical Analysis of Flow (ML/day)

Station	Number	Period of Analysis	Mean Daily	Median	Upper Quartile	Lower Quartile	Max	Min
Ovens River @ Peechelba	403241	1/1/1999 – 31/12/1999	2,649	1,609	3,305	430	22,177	183
		22/9/1998 – 31/121999	4,133	2,062	4,023	510	95,667	183
Black Dog Creek @ Parris Rd, Brimin	403247	1/1/1999 – 31/12/1999	24	0	13	0	843	0
		22/8/1998 – 31/121999	36	3	23	0	1,695	0
Indigo Creek	403248	24/6/1999 – 31/12/1999	52	17	37	12	1,319	3

4.3 Salinity Statistics

The salinity statistics presented in this report are all quoted in Electrical Conductivity (EC) units of microsiemens per centimetre, standardised to the value at 25^0C. The key salinity statistics are presented in Table 4.2 and time series plots of the raw data are included in Appendix A.

Table 4.2: Statistical Analysis of Salinity (µs/cm)

Station	Number	Period of Analysis	Flow Weighted Salinity	Mean Daily	Median	Upper Quartile	Lower Quartile	Max	Min
Ovens River @ Peechelba	403241	1/1/1999 – 31/12/1999	61	78	71	96	61	145	44
		22/9/1998 – 31/121999	54	74	68	87	57	145	37
Black Dog Creek @ Parris Rd, Brimin	403247	1/1/1999 – 31/12/1999	151	191	185	219	164	273	116
		22/8/1998 – 31/121999	139	190	186	218	166	273	47
Indigo Creek	403248	24/6/1999 – 31/12/1999	207	344	353	406	288	591	119

It can be seen from Table 4.2 that the salinity of Indigo Creek is quite a bit higher than Black Dog Creek, whilst the Ovens River is relatively fresh compared to both. It should be noted that only six months of data have been analysed for Indigo Creek and that this is during the period when flow and salinity levels appear to be highest. Given the start period of the data, it is not known whether salinity levels will vary significantly with seasonal variations in groundwater levels.

4.4 Salt Loads

There was no requirement to infill missing data for the two sites examined. Salt loads have been calculated as described above in Section 4.1. A summary of monthly salt loads is presented below in Table 4.3.

Table 4.3: Monthly 1999 Monthly Salt Loads

Month	Monitoring Station								
	Ovens River at Peechelba 403241			Black Dog Creek 403247			Indigo Creek 403248		
	Flow	Salt Load	FWS	Flow	Salt Load	FWS	Flow	Salt Load	FWS
January	15,162	895	98	0	0	N/A	N/A	N/A	N/A
February	8,245	504	102	0	0	N/A	N/A	N/A	N/A
March	14,121	748	88	0	0	N/A	N/A	N/A	N/A
April	11,751	637	90	0	0	N/A	N/A	N/A	N/A
May	13,428	885	110	0	0	N/A	N/A	N/A	N/A
June	105,901	3,868	61	128	12	153	100	19 (1)	316
July	90,454	3,169	58	586	69	197	563	110	326
August	251,446	7,940	53	2,924	242	138	4,305	380	147
September	259,079	9,039	58	4,107	363	147	2,293	280	206
October	88,113	3,344	63	715	74	172	906	174	320
November	66,914	2,624	65	101	13	223	449	102	378
December	42,170	1,727	68	26	3	215	1,267	157	207
Total	966,784	35,380	-	85,87	777	-	9,884	1,225	
Annual Flow Weighted Salinity	-	-	61	-	-	151	-	-	207

N/A = Data not available
(1) Figures do not represent entire month.

The key point to note about the information contained in Table 4.3 is that although the salt load in the Ovens River appears to be large, there is sufficient flow to reduce the flow weighted salinity to a low level.

5. Catchment Characteristics

The flow and salt loads generated within the Ovens catchment can be used to identify natural processes occurring in particular parts of the catchment. An important part in addressing this increase in salt mobilisation is to assess the catchment characteristics and to target the causes of salinity. In the Salinity Audit of the Murray Darling Basin (MDBC, 1999) it was estimated that the salt load mobilised from the Ovens catchment would increase from approximately 6,500 t/year to 14,000 t/yr by the year 2100. It should be made clear that this is an estimate of the increase in groundwater discharge and is not directly related to stream salt load. The predicted increase in stream salinity has been estimated to rise from the current level of 70 EC to 80 EC by the year 2100 (Note: The MDBC study was based on spot data for the Ovens River). Clearly the initial estimate is high compared to the estimate of 61EC (or ~63EC based on three streams) produced in this report.

A brief analysis aimed at assessing some of the characteristics that contribute to salinisation of the Black Dog and Indigo Creek catchments has been included in the following section.

5.1 Flow Characteristics

The flow statistics presented in Table 4.1 indicate that Indigo Creek discharges more volume and for a longer period of time than Black Dog Creek. It is possible that this is due to a flow that occurred in the Indigo Creek in December that did not occur in the Black Dog Creek (see Figure 8.1 to Figure 8.6 for plotted data). Flow duration curves have been constructed for these two sites to compare the characteristics of the two catchments. The flow duration curves were constructed over the largest period of concurrent data for direct comparison and are included in Appendix C.

The curves show that the two catchments are similar for flows of greater than 50 to 100 ML/day but there is a difference at flows lower than this. It is evident that Indigo Creek has a more persistent baseflow component than Black Dog Creek, which might suggest that groundwater discharge is more significant in this catchment. This might be attributable to the fact that the Indigo Creek drains a valley with steep terrain with a number of different geological features (refer to NESWG, 1997). Alternatively, land practices may differ between the two catchments, causing higher water table in the Indigo Valley. Additional data collection and/or more detailed hydrogeological investigation might improve the understanding of this relationship.

5.2 Flow and Salinity

The relationship between flow and salinity in each of the catchments has been examined using the plots included in Appendices E and F. The plots in Appendix E show that there is a strong correlation between flow and salt load in each of the two catchments. It is unclear from this whether salinity is due to surface washoff or from groundwater processes.

The plots in Appendix F show the relationship between flow and salinity. It is evident that salinity of the stream increases most noticeably during flows of less than ~40 ML/day in Black Dog Creek and at ~70 ML/day in Indigo Creek. For a similar flow, say 50ML/day, it is clear that Indigo Creek has a higher salt concentration. This could suggest that the Indigo Creek is being affected by saline discharge from a groundwater source and would suggest that there is a stronger connection between surface water and saline groundwater discharge areas in the Indigo Creek catchment. However, it should be recognised that this is based on an extremely limited data set. Further information regarding the hydrogeology in the two catchments and additional surface water data would need to be analysed to confirm this preliminary assessment.

6. Conclusions

This report has assessed flow and salinity data from the Ovens Catchment. The following conclusions have been drawn:

- The data collection program for 1999 was of excellent standard, with only twenty six days having a quality code greater than 3. These data were mainly missing due to the rating being exceeded at Site 403248 and were estimated by extrapolation of the rating table. The accuracy of this data will be updated as Thiess measure higher flows and update the ratings in the future.
- The flow weighted salinities for the Ovens River and Black Dog Creek sites are calculated for the entire year. The Indigo Creek site flow weighted salinity is based upon six months of data and although the flows could be expected to be minimal during the preceding six months this may not be representative of an annual figure. Care should be taken not to treat the reported flow weighted salinity as an annual figure for Indigo Creek.
- Although the Ovens River transports a large quantity of salt to the Murray River, the flow is sufficient to significantly dilute this as demonstrated by the reasonably low flow weighted salinity.
- There is only a very limited quantity of data currently available with which to assess catchment trends and characteristics. It would appear that the Indigo Creek catchment is affected by groundwater discharge more than the Black Dog Creek catchment.
- The estimated flow weighted salinity from the Ovens catchment in the Salinity Audit of the Murray Darling Basin (MDBC, 1999) is slightly high compared to the 1999 data analysed. The original estimate was based on spot data. There is insufficient data available to comment on trends in catchment salt loads.
- The mean annual flow for 1999 could be expected to be lower than the long-term average due to the dry climatic conditions. This could have influenced flow weighted salinity calculations.

7. Recommendations

It is recommended that:

- Monitoring of flow and salinity continue to provide an indicator of the effectiveness of the North East Salinity Strategy (NESWG, 1997).
- Thiess continue to review the ratings at each of the three sites on a regular basis.
- Investigations continue to determine the feasibility of establishing flow and salinity monitoring stations at two additional sites (Buffalo River and Fifteen Mile Creek) and water quality monitoring at Reedy Creek and the Ovens River at Wangaratta as recommended by the North East Salinity Strategy.
- A review of the Three Mile Creek data be included in the next annual review of stream salinity.
- Analysis of catchment characteristics be revised and possibly extended as additional data becomes available. Climate data and groundwater trends could also be examined in conjunction with catchment characteristics in the future.

8. References

Murray Darling Basin Ministerial Council, 1999. The Salinity Audit of the Murray-Darling Basin – A 100-year Perspective, 1999.

North East Salinity Working Group, 1997. *Reversing The Trend - Draft North East Salinity Strategy,* Department of Natural Resources and Environment, December 1997.

Personal Communication – Bill Mitchell of Thiess, Wangaratta, 11/6/1999.

Appendix A - Time Series Plots

Figure 8.1: Flow and Salinity Plots @ Site 403241(Ovens River @ Peechelba) - 1999

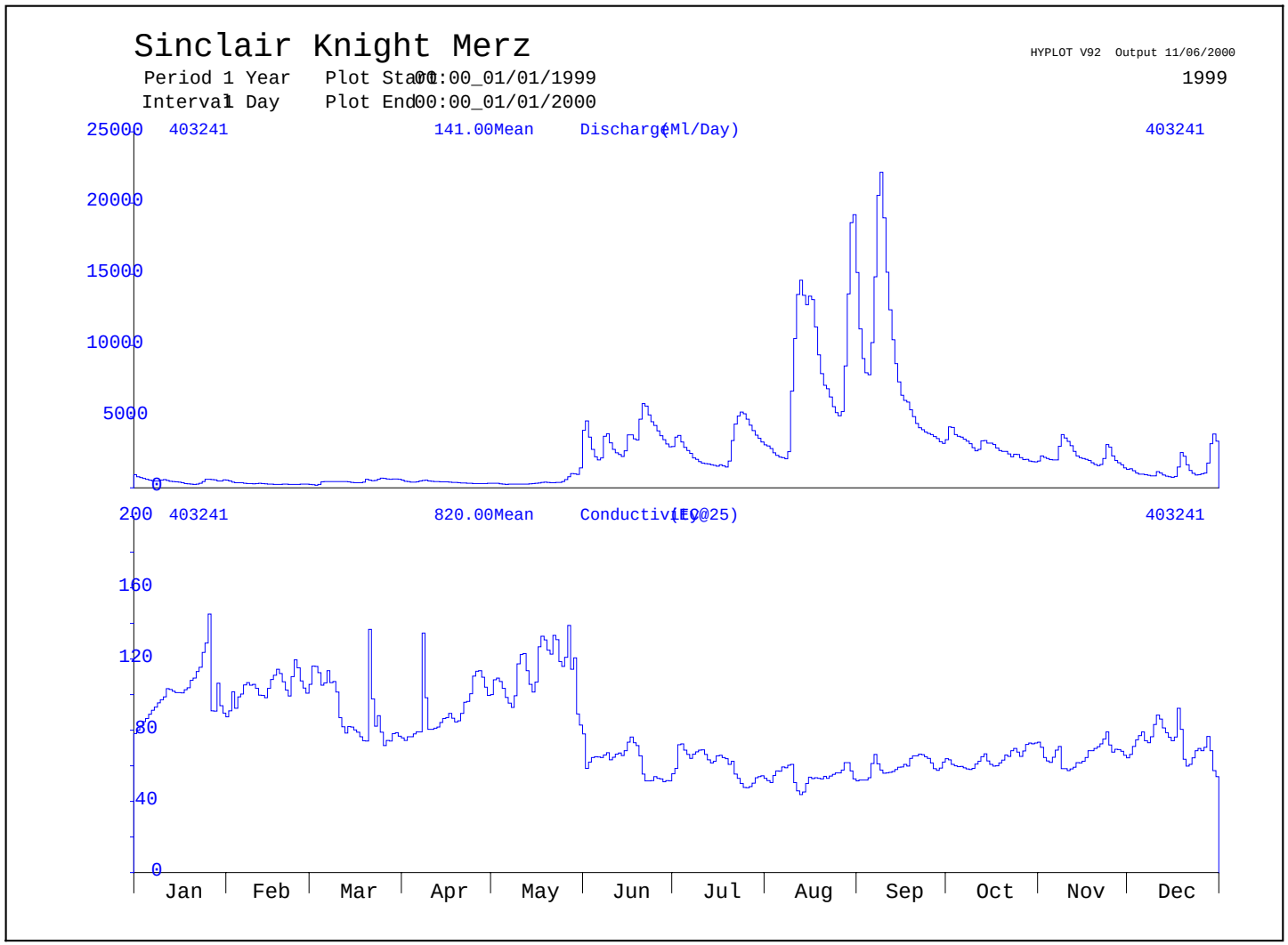


Figure 8.2: Flow and salinity @ Station 403241 (Ovens River @ Peechelba) (Finer Resolution)

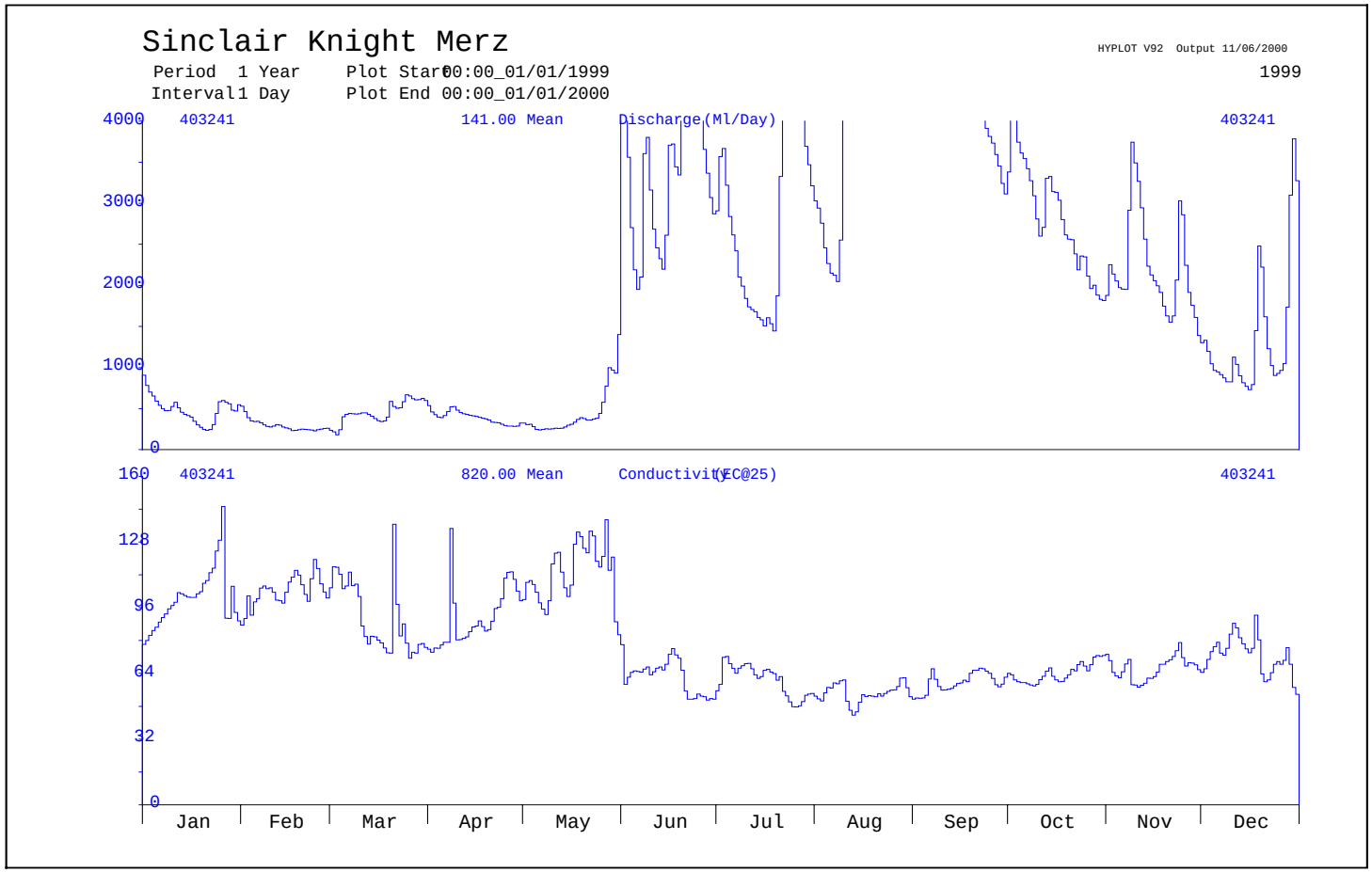


Figure 8.3: Flow and Salinity Plots @ Site 403247 (Black Dog Creek @ Brimin) - 1999

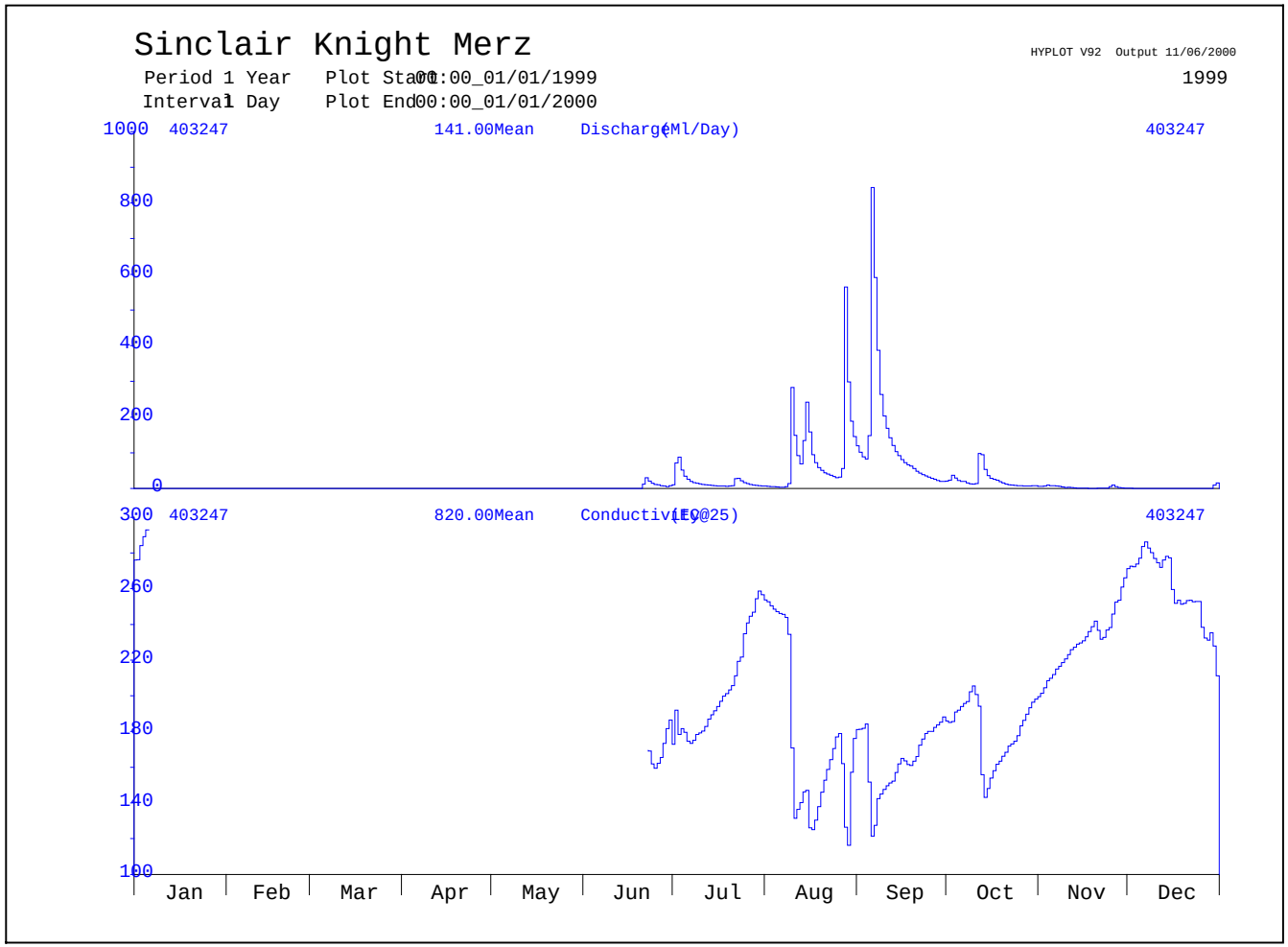


Figure 8.4: Flow and Salinty @ Site 403247 (Black Dog Creek @ Brimin) (Finer Resolution)

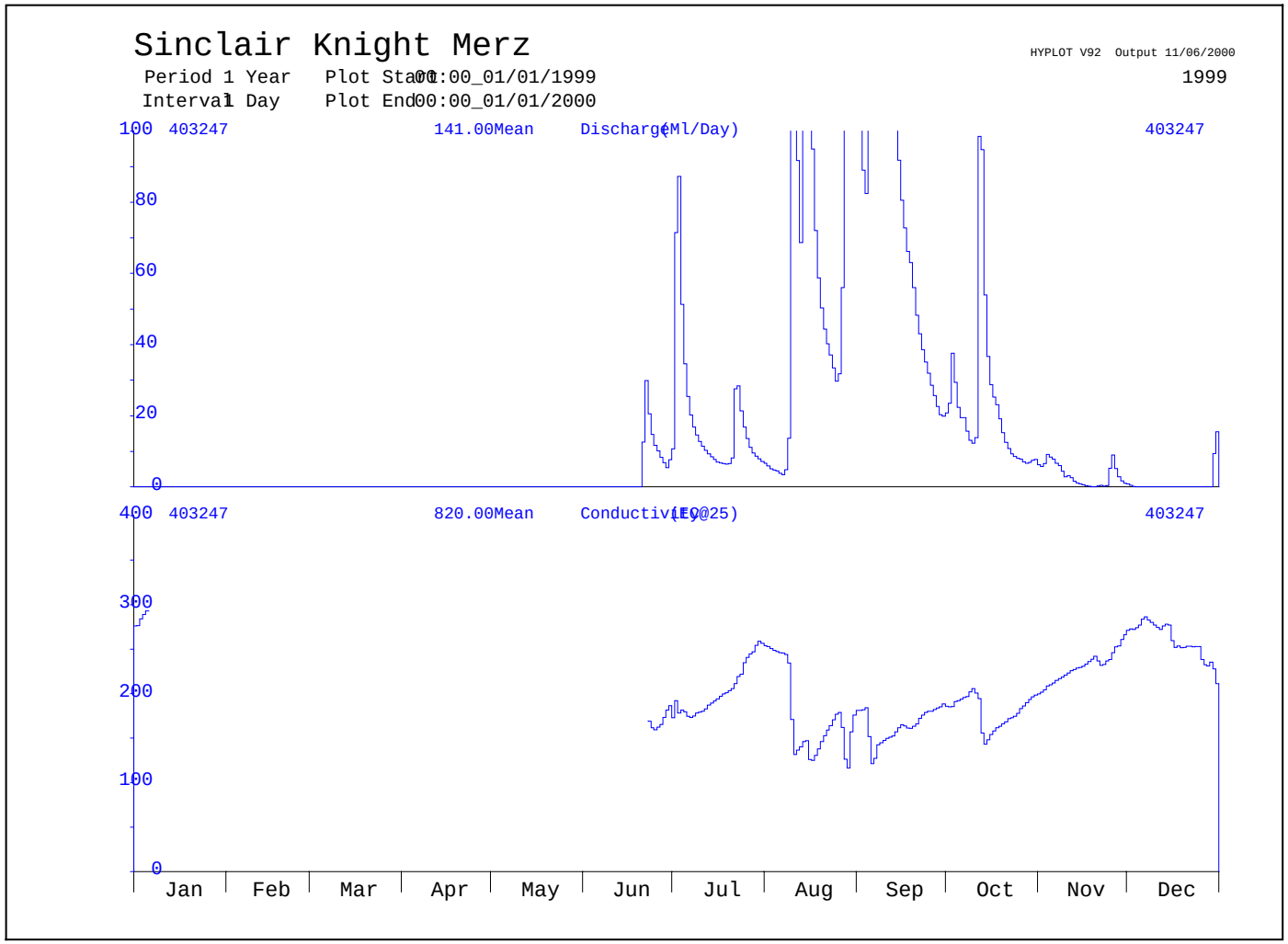


Figure 8.5: Flow and Salinity Plots @ Site 403248 (Indigo Creek) - 1999

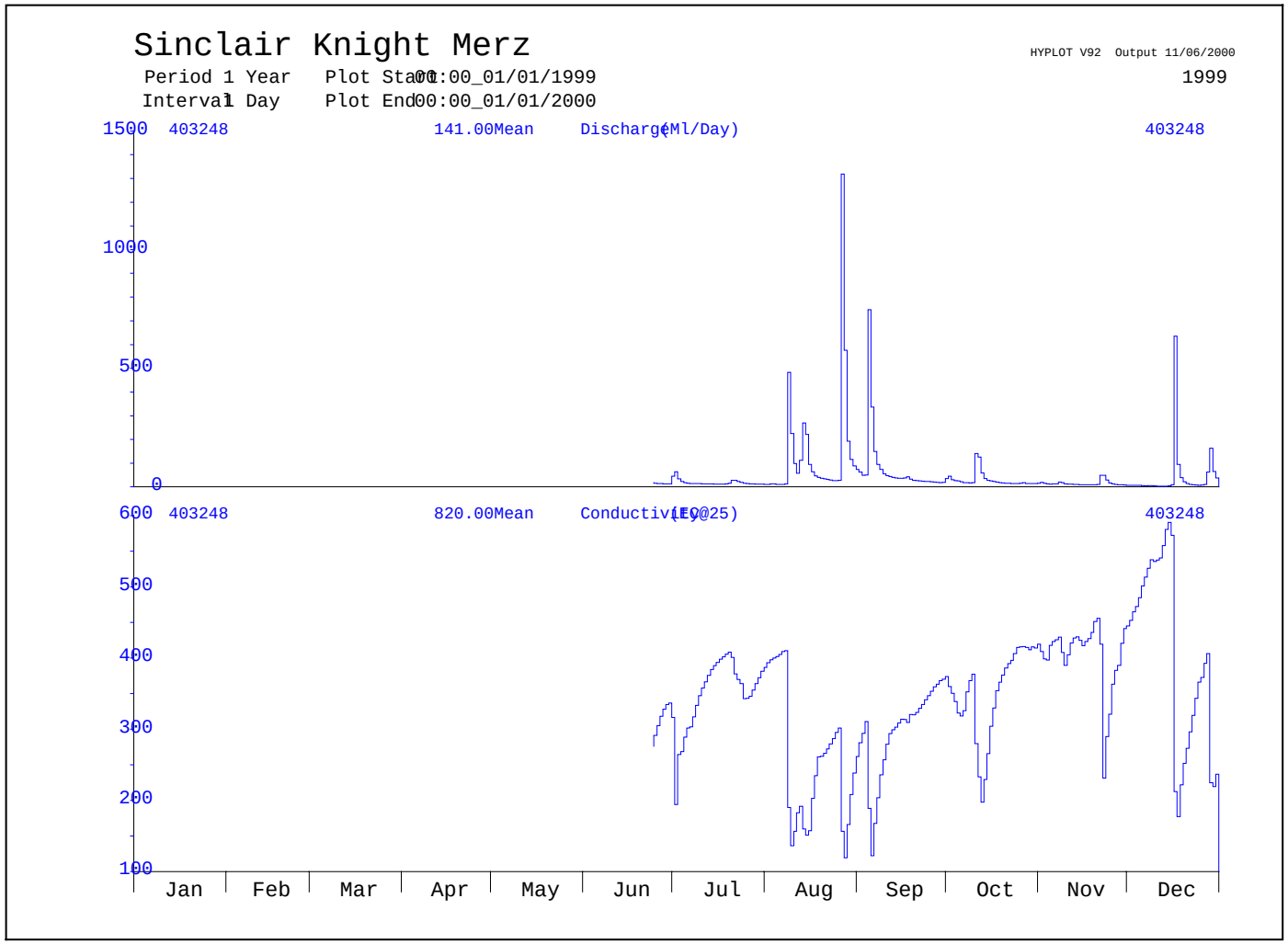
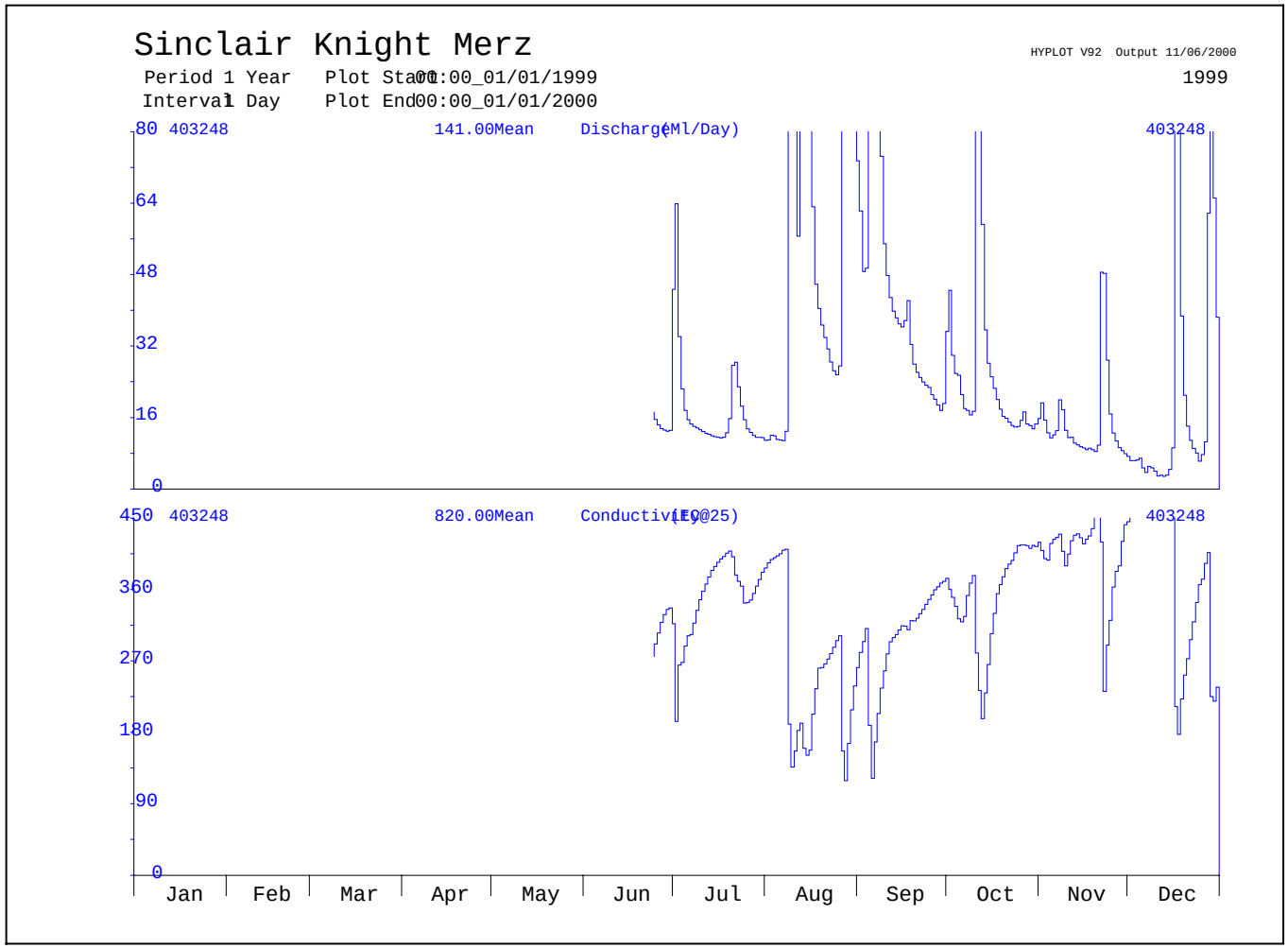


Figure 8.6: Flow and Salinity @ Station 403248 (Indigo Creek) (Finer Resolution)



Appendix B - Missing Data

Table 8.1: Missing Data - 1998

Station	Number	Parameter	Raw Data Missing (1)	Estimated During Processing (2)	Final Data Missing (3)	Comment
Ovens River at Peechelba	403241	Flow	0	0	0	-
		Salinity	0	0	0	-
Black Dog Creek at Paris Rd, Brimin	403247	Flow	0	0	0	-
		Salinity	1	0	0	-
Indigo Creek	403248	Flow	0	0	0	-
		Salinity	26	0	26	Additional gauging required

Note : Missing salinity data during periods of no flow were not included in the above table, as salinity data is not expected in a dry stream.

(1) Raw data missing - is classed as the data obtained directly from the on site logger.

(2) Estimated during processing - is classed as the data which has been estimated by Thiess during initial processing.

(3) Final data missing - is classed as the data which cannot easily be estimated and is classed as missing.

The following data is not classed as missing from the raw data set:

- Estimated data with a quality code of 15* or less is considered good quality data.

Appendix C - Estimated Data

Table 8.2: Number of Days With Quality Codes Greater Than 1, 1999

Station	Station	Parameter	2	3	150	Flow QC 2-99	Flow QC 100-150	Salinity QC 2-99	Salinity QC 100-150
Ovens River	403241	Flow	21	14	0	35	0	-	-
at Peechelba		Salinity	20	7	0	-	-	27	0
Black Dog Creek at	403247	Flow	124	12	0	136	0	-	-
Paris Rd, Brimin		Salinity	0	0	0	-	-	0	1
Indigo Creek	403248	Flow	0	0	25	0	25	-	-
		Salinity	35	1	0	-	-	36	0

2 Good quality edited data
3 Linear interpolation across gaps in record
150 Rating extrapolated due to insufficient gaugings

Comments

The quality code (QC) is used to represent the accuracy of the data. The higher the QC the less accurate the data is. QC's between 1 and 99 are classed as good reliable data with QC's from 100 to 150 classed as estimated data of less accuracy. Users need to be aware that data with quality codes higher than 99 should be re-examined before use in any important study.

The following comments are made regarding the estimated data presented in Table 8.2:

- A quality code of 3 (linear interpolation across gaps in records) is used when there are very small gaps in the record. Small gaps in the record appear on a regular basis and are caused when data recording is interrupted while data is downloaded. In such cases infilling by linear interpolation is satisfactory. This data was previously coded 82, but a change to code 3 is considered appropriate where the periods of missing data are very short, and the hydrographers who were downloading data at the site are able to confirm that no unusual events occurred.
- A quality code of 150 indicates that insufficient measurements at high flows have been taken. Although this is the best estimate of flow at present, further high flow measurements will improve the accuracy of high flow records.

Appendix D - Flow Duration Curves

Figure 8.7: Ovens River @ Peechelba

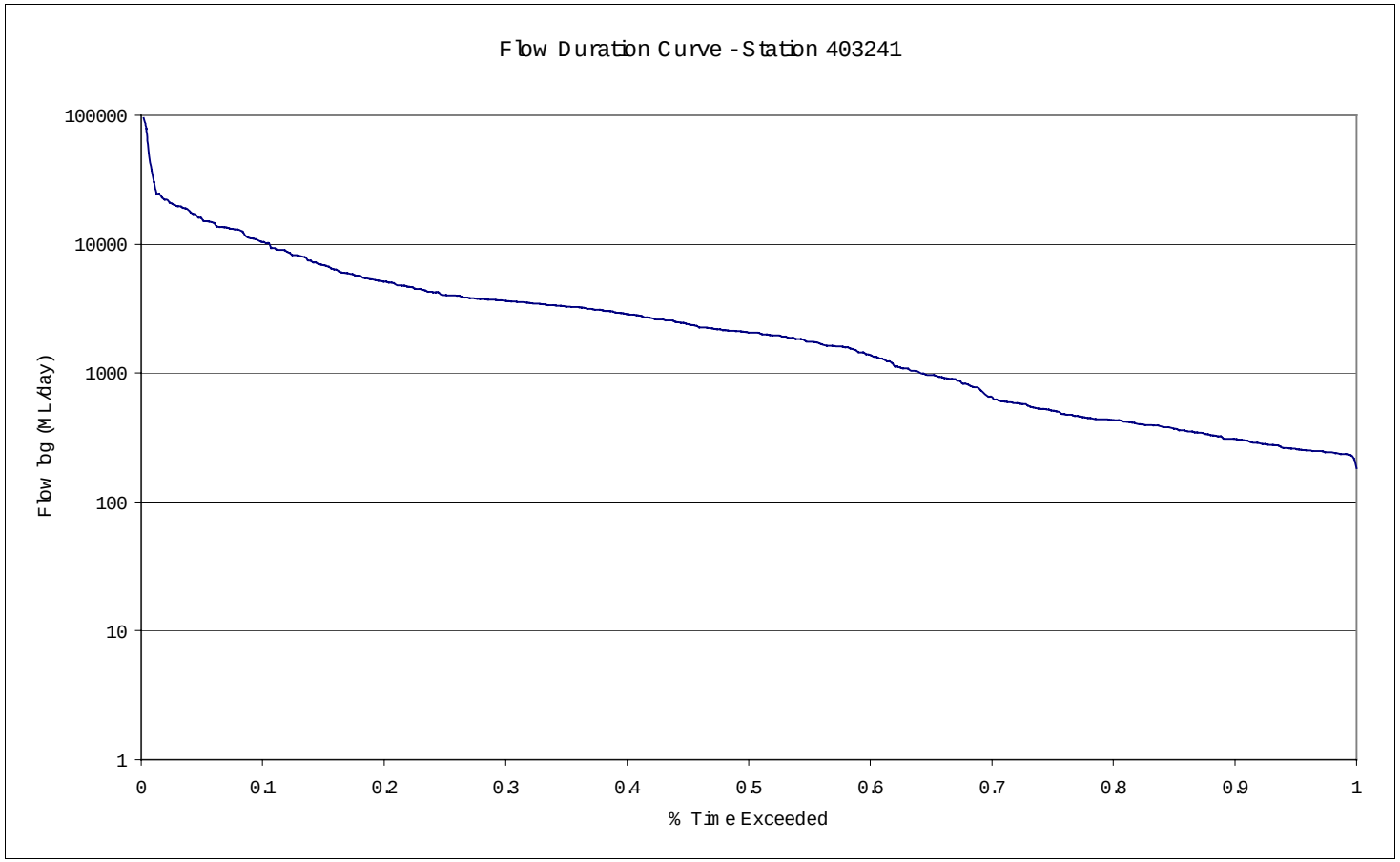
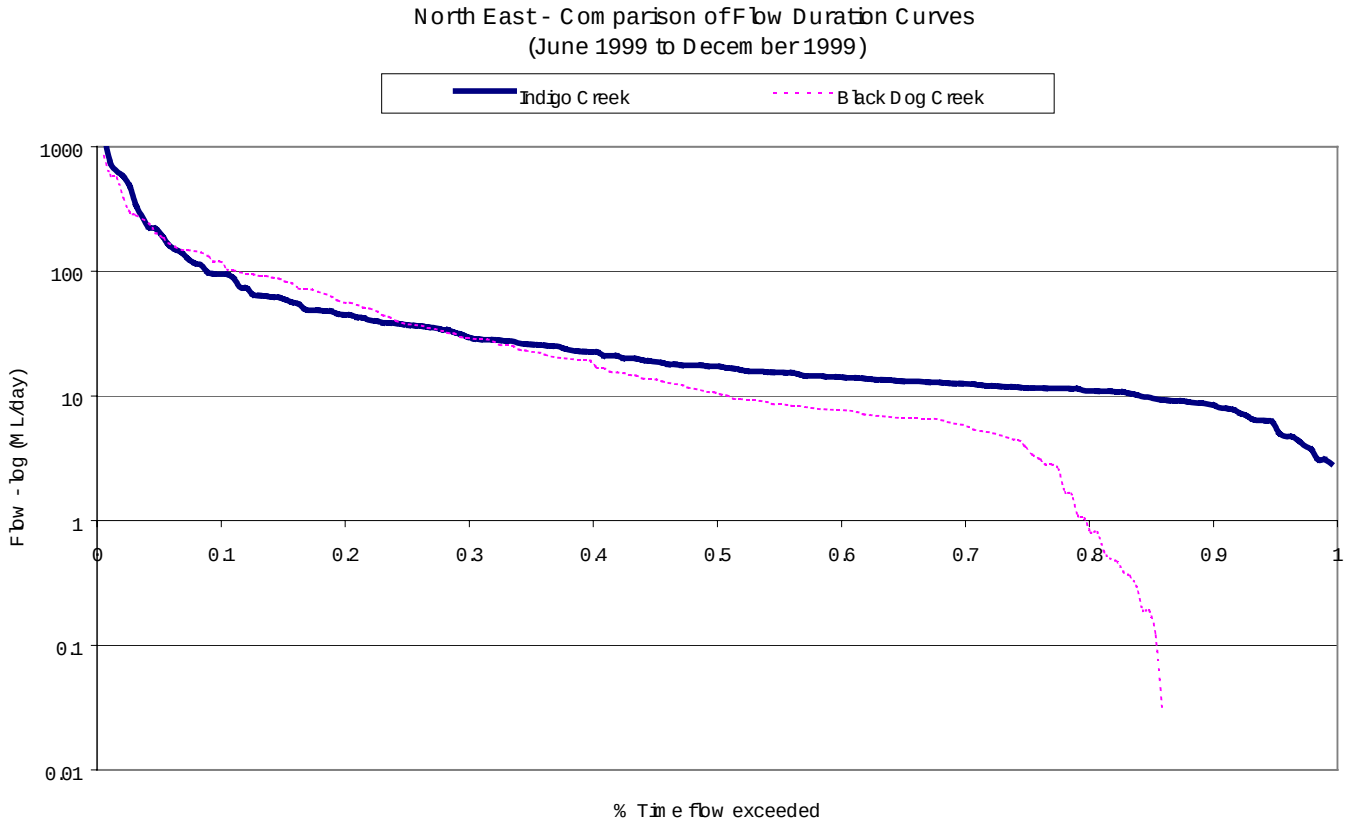


Figure 8.8: Black Dog Creek and Indigo Creek



Appendix E - Flow vs Salt Load Plots

Figure 8.9: Flow vs Salt Load – Indigo Creek

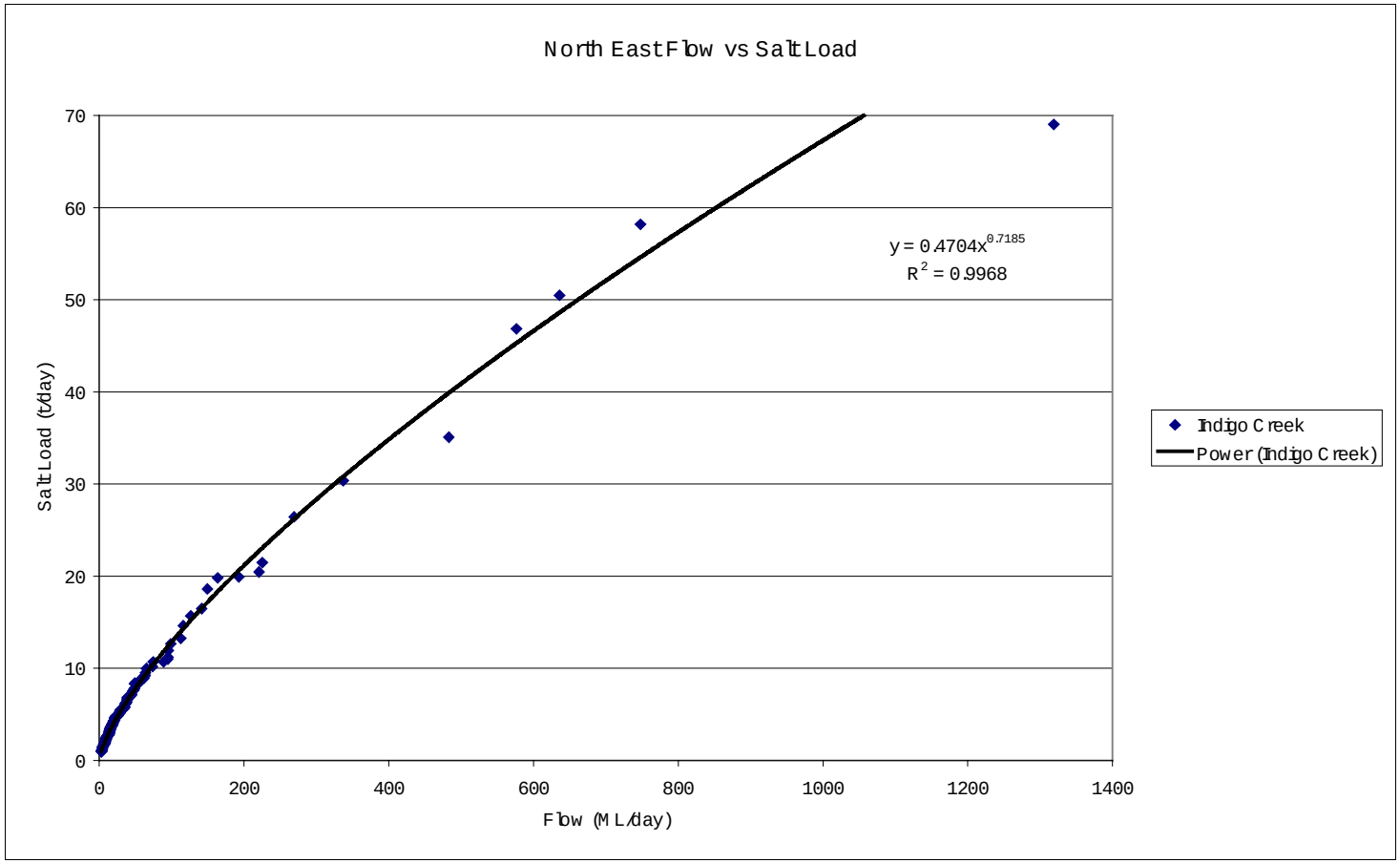
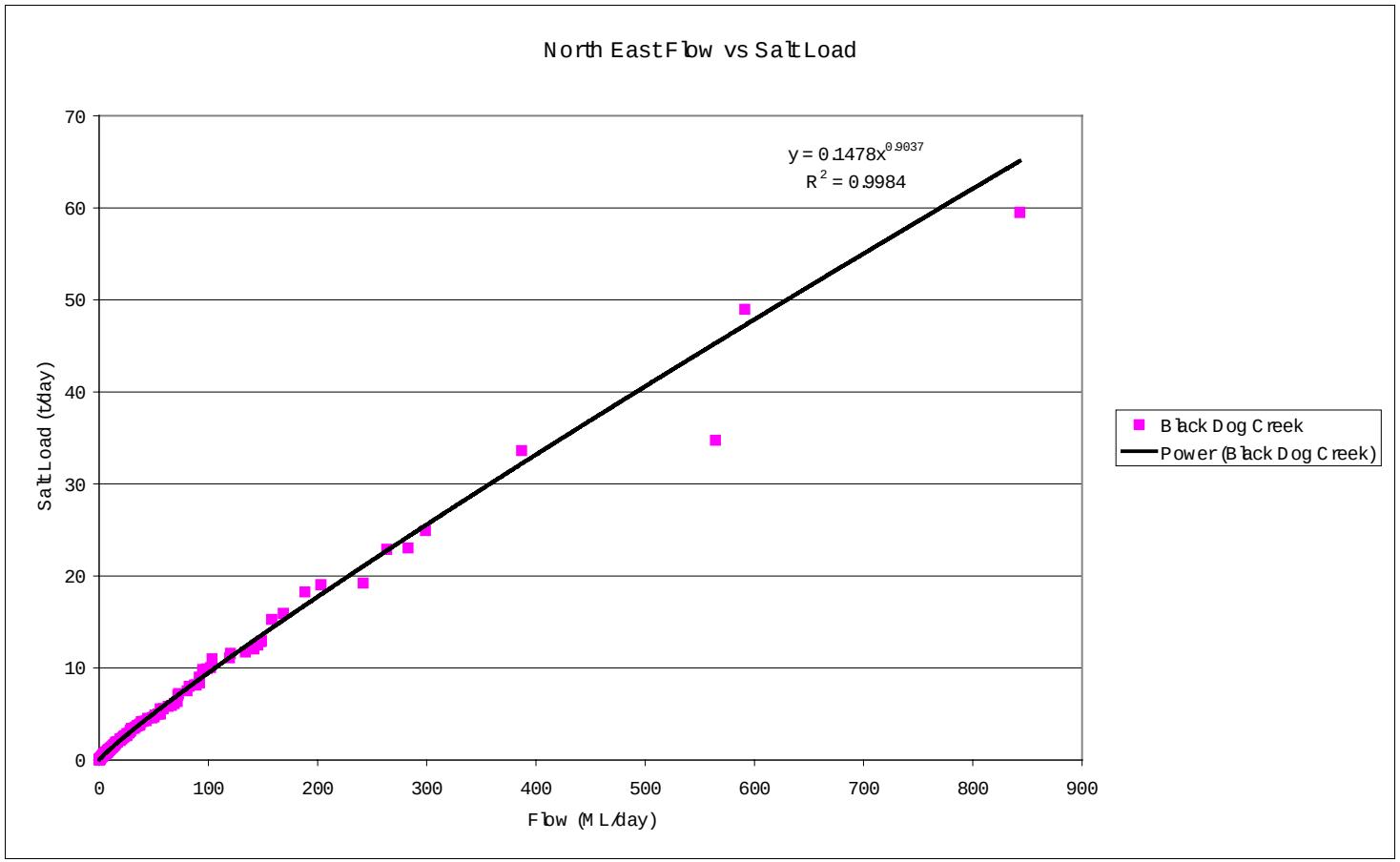


Figure 8.10: Flow vs Salt Load – Black Dog Creek



Appendix F - Flow vs Salinity Plots

Figure 8.11: Flow vs Salinity @ Station 403248

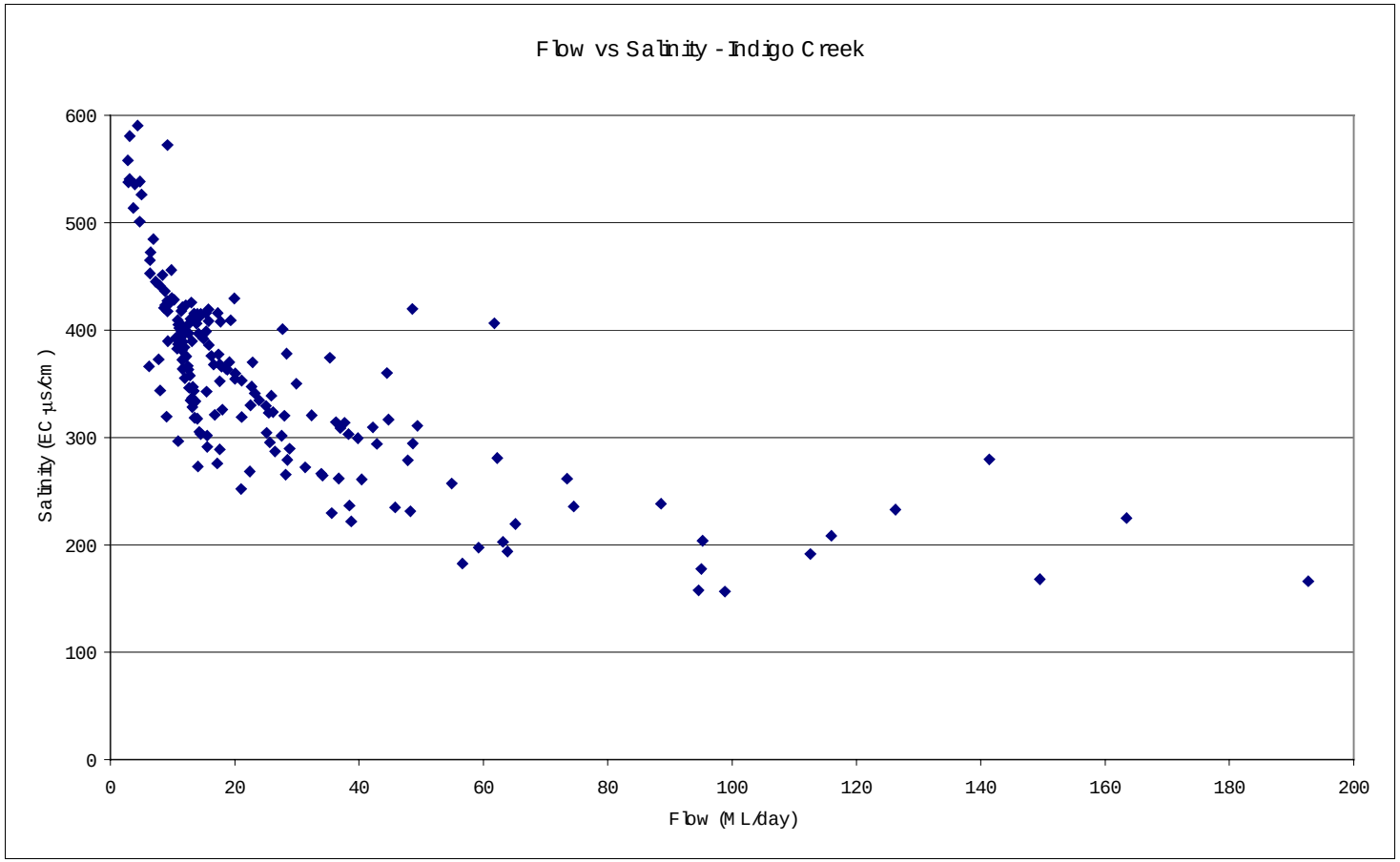


Figure 8.12: Flow vs Salinity @ Station 403247

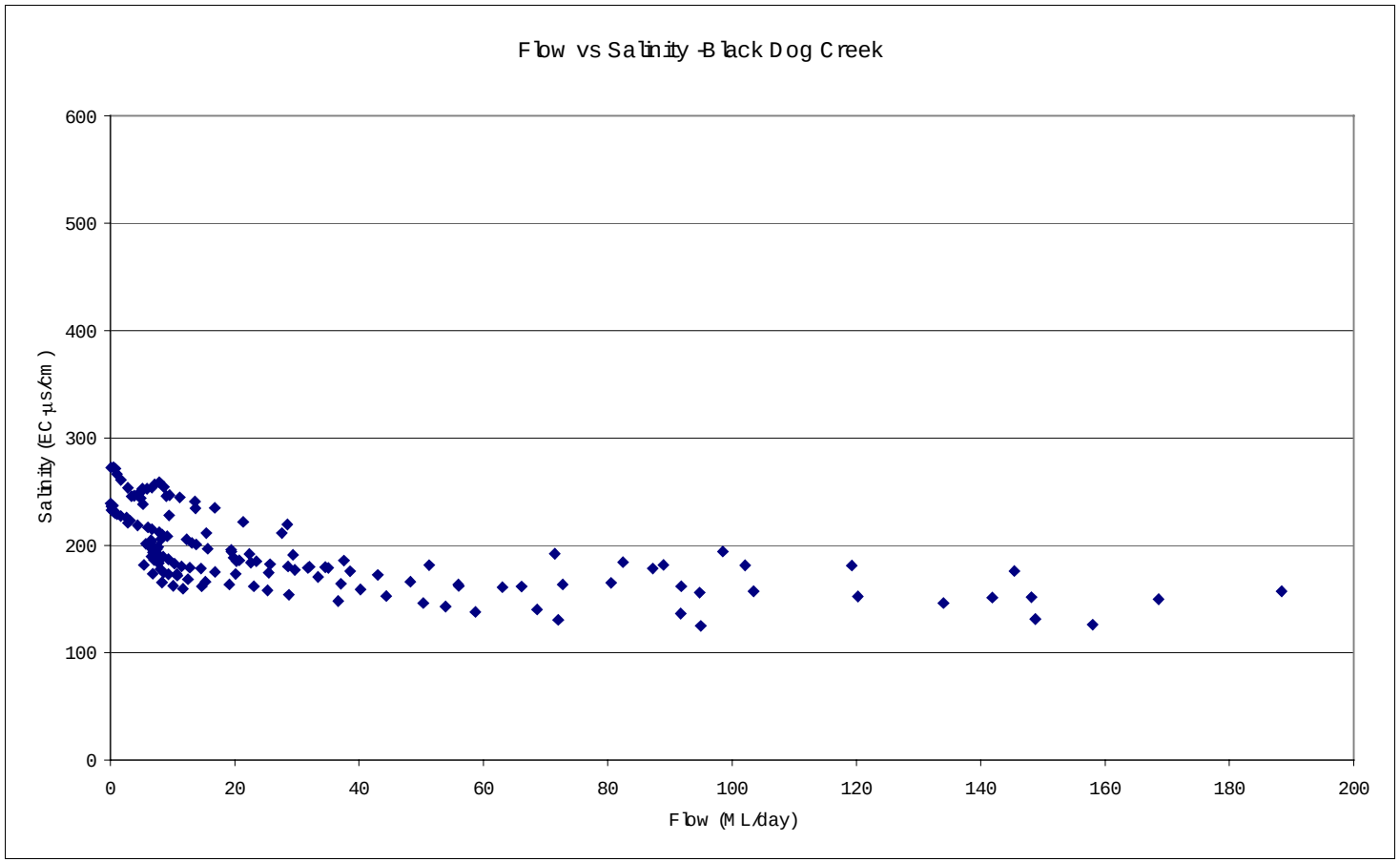


Figure 8.13: Flow vs Salinity @ Station 403241