

NELSON LEASE GEL POLYMER TREATMENT
PERFORMANCE REPORT

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SUBMITTED TO
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OBJECTIVE:

The Nelson Lease operated by Russell Petroleum Co. has been under waterflood since 1981. It was believed that the flood was performing poorly due to water channeling problems. In April 1986, six polymer profile modification treatments were undertaken to help correct this problem. In the fall 1987, an additional five treatments were implemented. The objective of this report is to evaluate the performance of the polymer treatments by examination of the lease production data.

LOCATION:

Russell Petroleum's Nelson Lease is located in Allen County, Kansas in the Savonburg Field, T26S,R21E, Section 21.

BACKGROUND

The waterflood patterns consists of irregular 5-spots. A map is presented in Figure I. The eleven polymer gel treatments were implemented with polymer solution injected in eleven separate water injection wells. Treatment solution consisted of polyacrylamide, sodium dichromate, and a reducing agent which was thiosulfate or thiourea. Thiourea was only used as a reducing agent in the treatment of RW-11. Treatment volumes were:

SPRING 1986

RW-11 45.5 bbls
RW-3 46.0 bbls
HW-31 59.0 bbls
RW-7 60.0 bbls
KW-51 80.0 bbls
RW-8 200 bbls (Dec. 86)

FALL 1987

KW-6 188.0 bbls
HW-1 96.0 bbls
HW-23 199.0 bbls
HW-18 197.0 bbls
H-29 192.0 bbls

For the remainder of the report, each treated pattern will be identified by the injection well number.

POST TREATMENT ANALYSIS PROCEDURE:

Each of the eleven inverted five spot patterns were individually studied. First, all producing wells surrounding a treated injector were identified. Production history from bucket test data for each well was summed and the following graphs were made for each inverted five-spot: oil production vs. time, WOR vs. time, and water production vs. time. When possible decline curve analysis was performed on the entire pattern. Finally, all of the inverted five-spot production data were combined into a cumulative file for the entire treated portion of the reservoir. It was hoped that by looking at all the pattern data together, many anomalies would be smoothed out and a more accurate picture of the reservoir performance could be seen.

For the injection well in each pattern, plots of injectivity index vs. time, were prepared.

An incremental oil analysis was performed on eight of the individual inverted five-spot patterns. The remaining three patterns had little to no response in incremental oil. First, a base decline rate was calculated using historical data taken prior to the treatment date. This decline curve was then extrapolated to predict the pattern behavior had no treatment been performed. Then incremental oil rate was found by subtracting this extrapolation from the actual production rate data obtained subsequent to gel polymer treatment.

Another analyses was used in which the cumulative production of all the treatments were summed. In this method, all the treatments were summed using individual well bucket-test data and a decline curve analysis was conducted. Figure II shows total oil production versus time for all treated patterns along with a decline curve. Figure III presents a plot of the producing water-oil ratio for all treated patterns.

Oil production data from the Nelson lease battery which depicts actual oil sales from the entire field is presented in Figure IV. When comparing Figure II (data from bucket tests) to Figure IV (data from battery) a similar trend can be noted. This comparison increases the validity of the bucket test data. Figure V presents a comparison of overall injection rate, oil and water production. Figure VI presents the overall producing water-oil ratio as a function of time. Figure VII is a plot of cumulative oil production versus cumulative brine injection for the entire field. It provides an indicator of waterflood efficiency. The steeper the curve, the more oil produced per barrel of brine injected.

SUMMARY OF THE RESULTS:

Graphical results for all the treated five-spots are presented in the appendix. Five-spot patterns with significant incremental oil were analyzed separately with the following results as of May 1988. Incremental oil is based on the calculation described above and is for the period of April 1986 to May 1987.

<u>Well</u>	<u>Incr. Oil</u>	<u>Well</u>	<u>Incr. Oil</u>
RW-3	2948	KW-6	2315
KW-51	3705	HW-23	490
RW-7	915		
RW-11	235		
RW-8	2418		
HW-31	1018		

Note: Some of the inverted five-spots share production wells. Incremental oil from those common production wells was not divided between treated patterns. For that reason a summation of incremental oil for each treated pattern would be misleading.

Of the eleven wells treated, only patterns H-18, H-1, and H-29 have failed to have significant incremental oil to date.

Decline curve analysis was also conducted on the summation of all the treated patterns. This resulted in the estimate of incremental oil being 8837 bbls. Figure II presents the decline curve along with incremental oil. The decline rate prior to treatment was estimated at 30%.

INDIVIDUAL PATTERN RESULTS

WELL RW-3 (Date Treated - 3-31-86) (size - 50 bbls)

The five spot pattern with the injector RW-3 at its center appears to have had the best response to the polymer treatment of all the patterns treated. This injection well is bounded by the following production wells: H-16, H-17, K-32, and K-33. K-33 has been shut in, however will flow at surface if permitted. H-16 has shown the most positive response.

The following table presents average bucket tests three months before and after treatment.

Well #	H-16		H-17		K-32		K-33	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	4.0	80.0	3.5	80.0	0.8	35.0	SI for 2 yrs	
After:	<u>9.0</u>	<u>30.0</u>	<u>3.5</u>	<u>50.0</u>	<u>1.1</u>	<u>10.0</u>		
Change:	+5.0	-50.0	0.0	-30.0	+1.3	-15.0		

The oil production for the entire pattern is presented in Figure A1. The entire pattern had a decline rate of 36% prior to the treatment. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 2948 barrels. The WOR and water production are presented on Figures A2 and A3 respectively. The plots indicate that channeling might still be a problem, especially after both acid clean-ups.

Over its history RW-3 has had a general loss of injectivity. However, since the treatment the injectivity index decline appears to have stopped and injectivity has leveled off at a constant value. (See Figure A4) It is questionable as to whether one can credit this stabilization to the treatment, as the injectivity was already stabilizing prior to the treatment.

Two acid clean-up treatments have been conducted to increase injectivity as presented in the Figure A4. The injectivity index did respond to the first clean-up. Figure A2 depicts an unfavorable water production response following both acid cleanups.

OIL PRODUCTION VS. TIME

Nelson Lease, RW-3 five spot

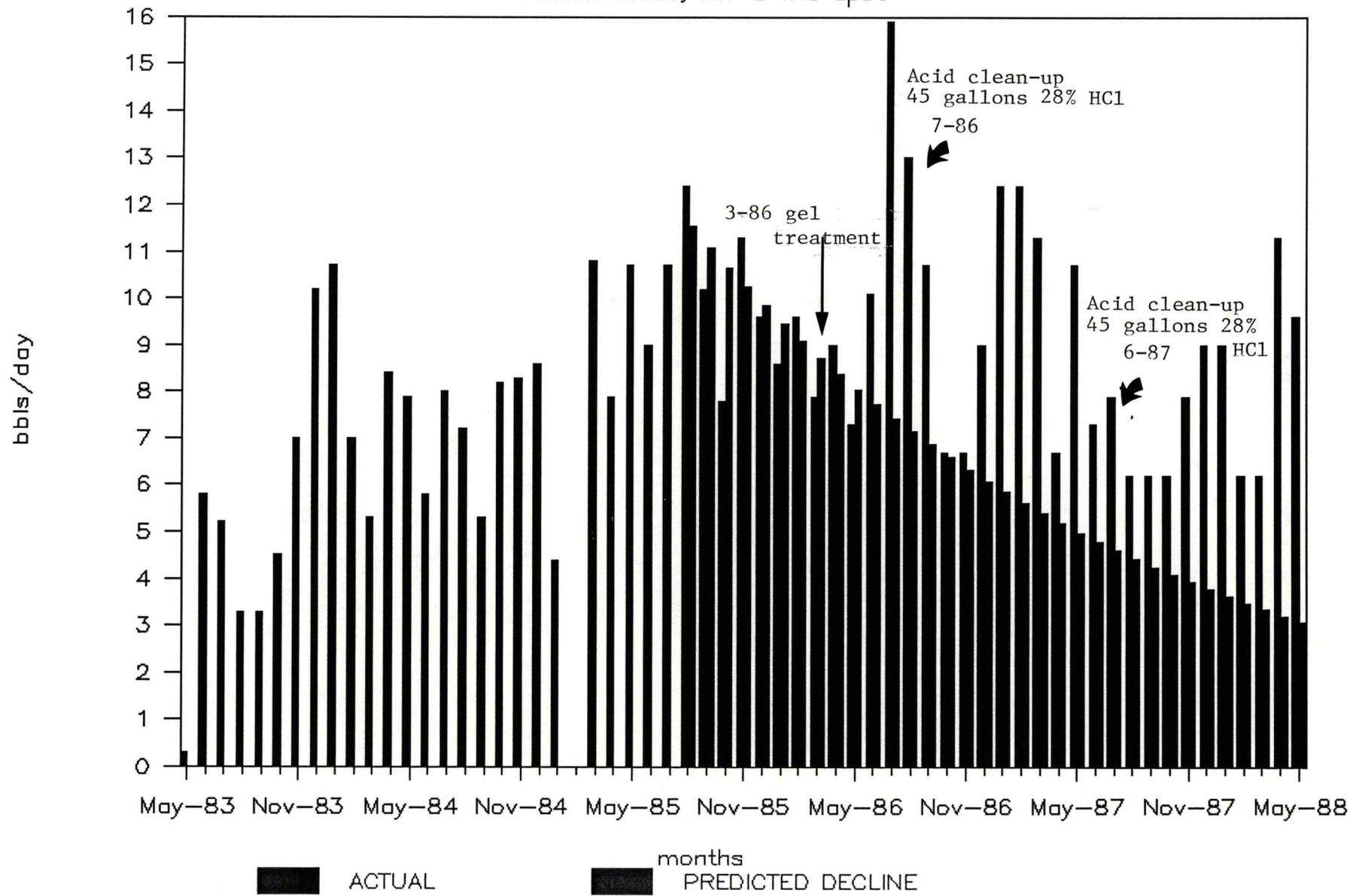


FIGURE A1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, RW-3 five spot

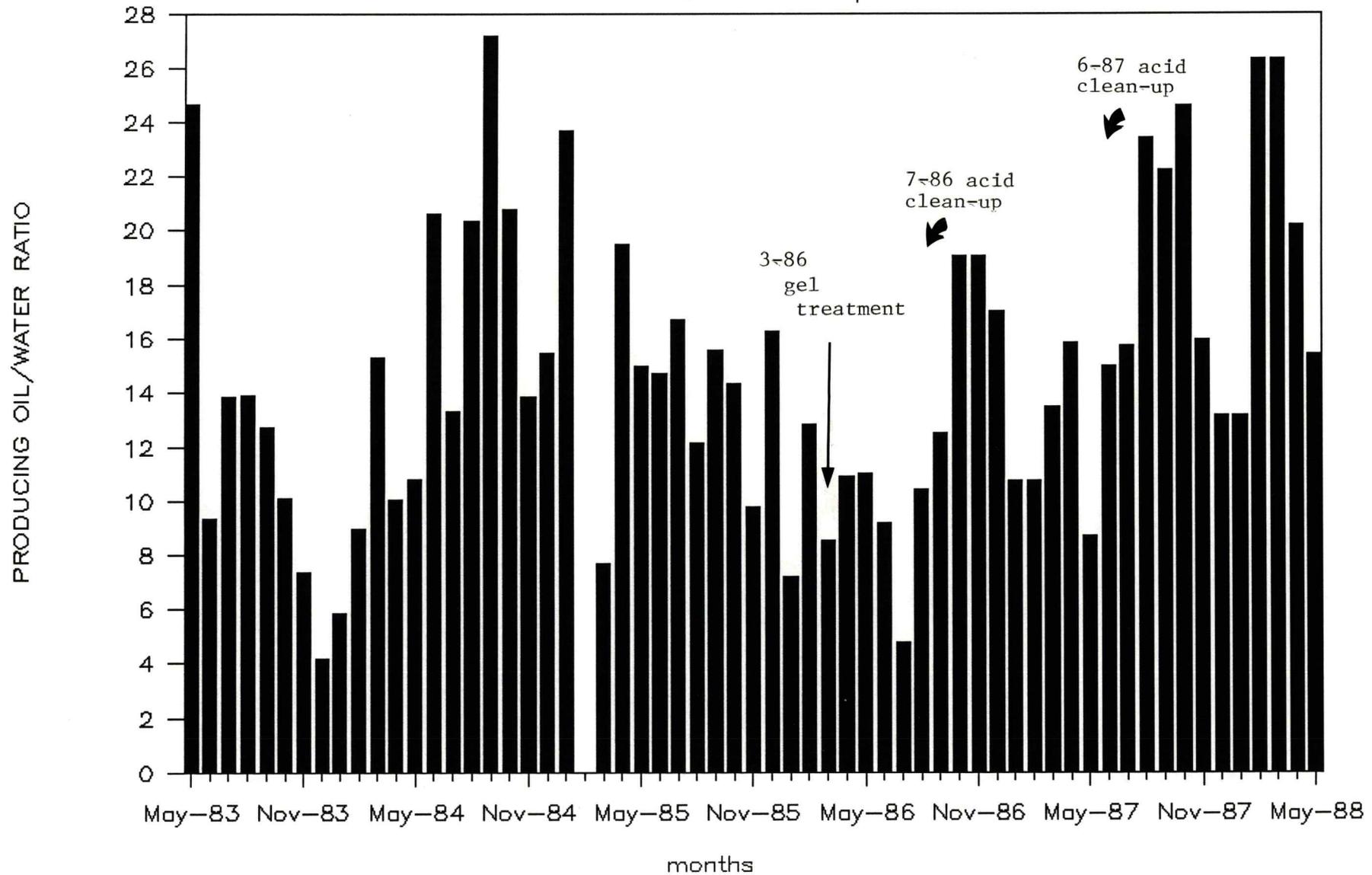


FIGURE A2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, RW-3 five spot

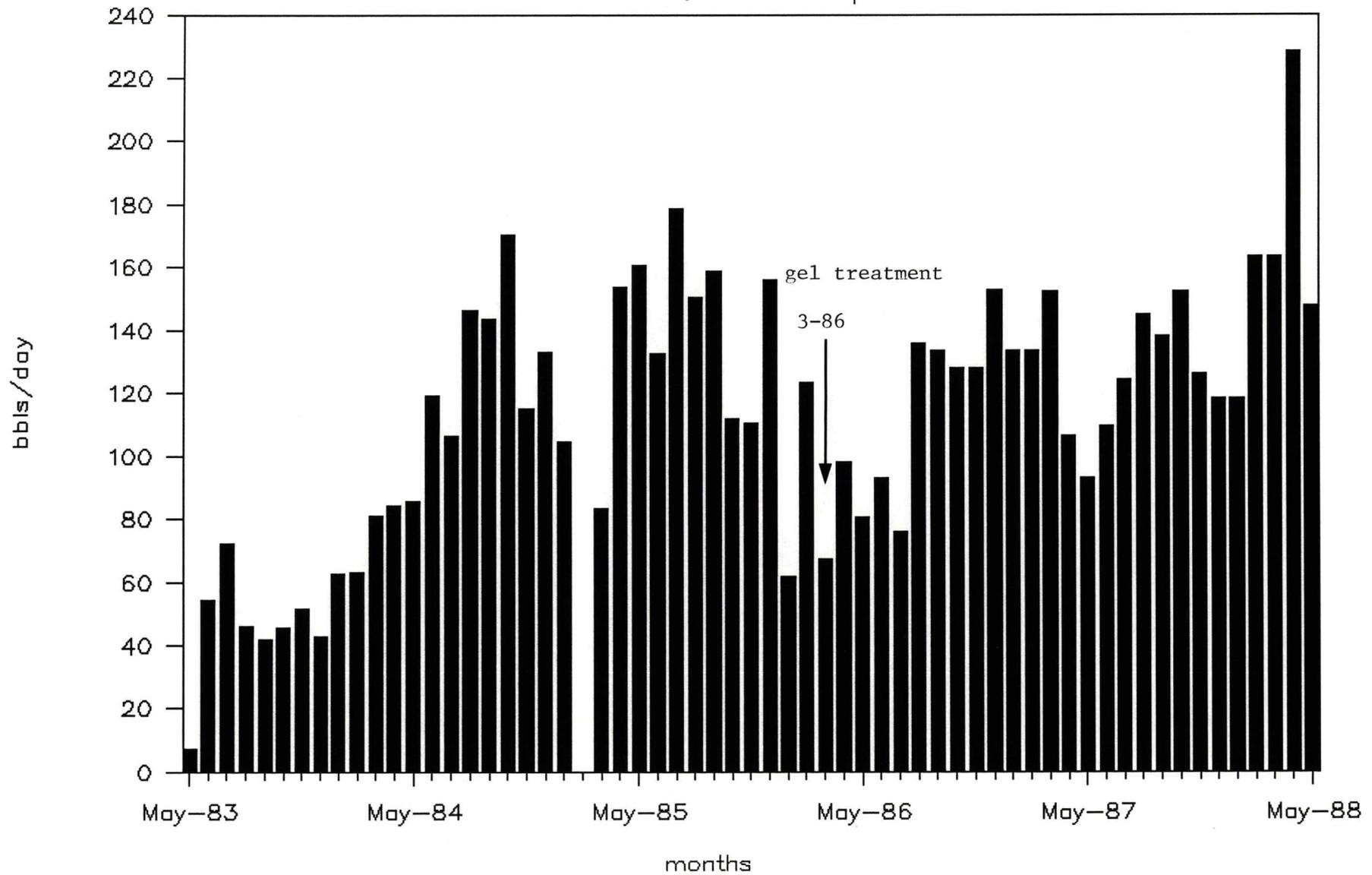


FIGURE A3

INJECTIVITY INDEX VS. TIME

Nelson Lease, RW-3

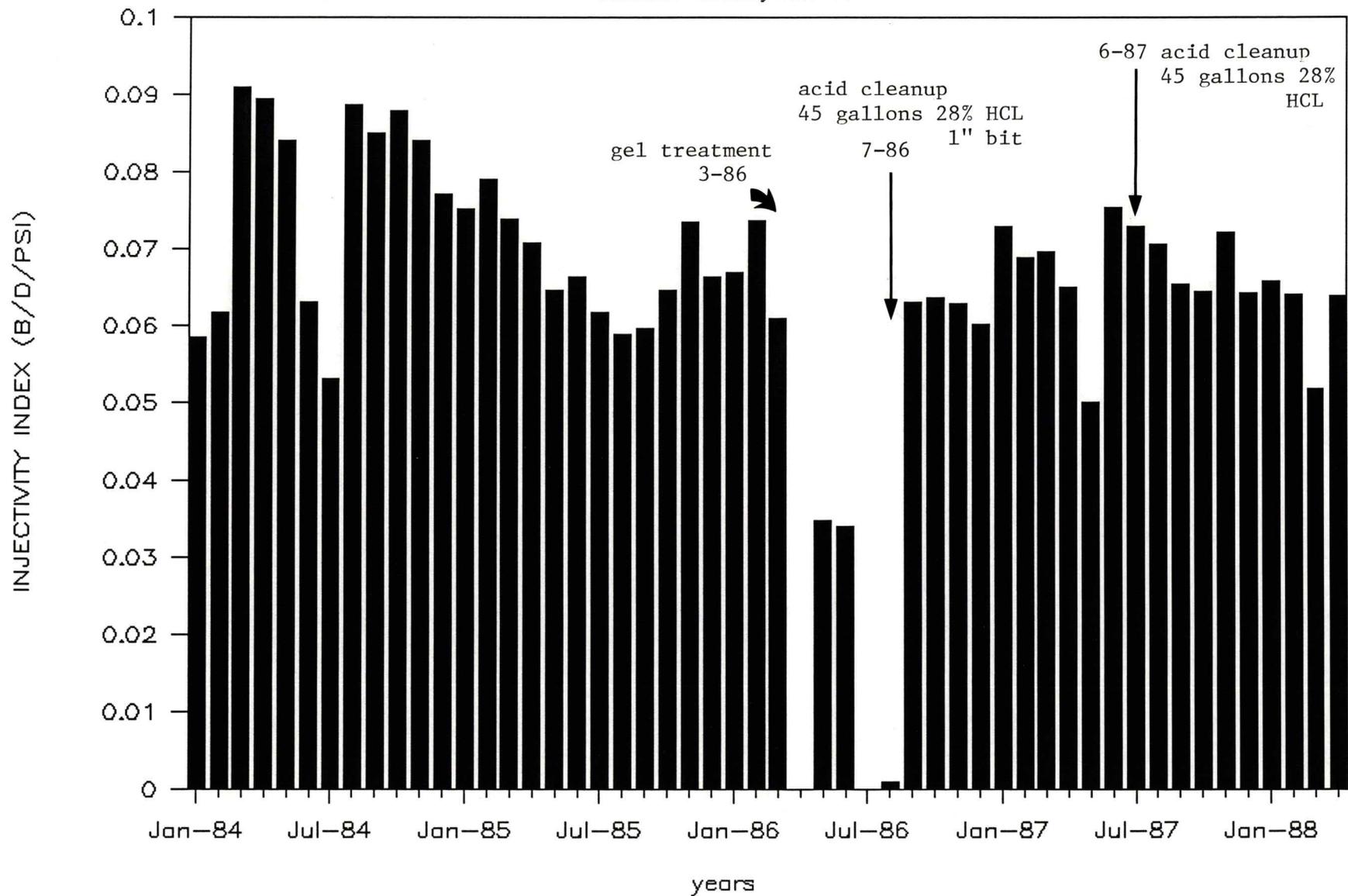
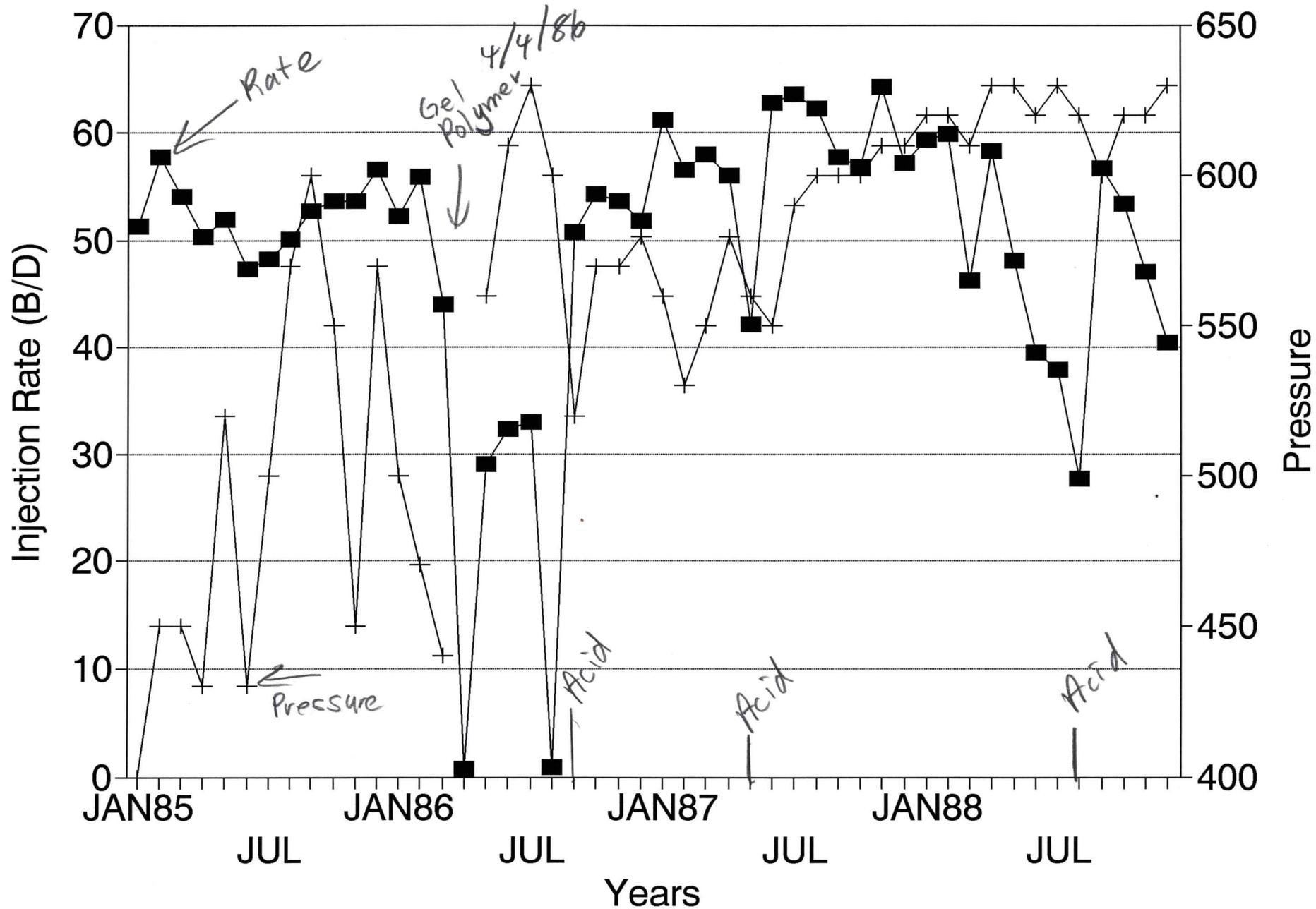
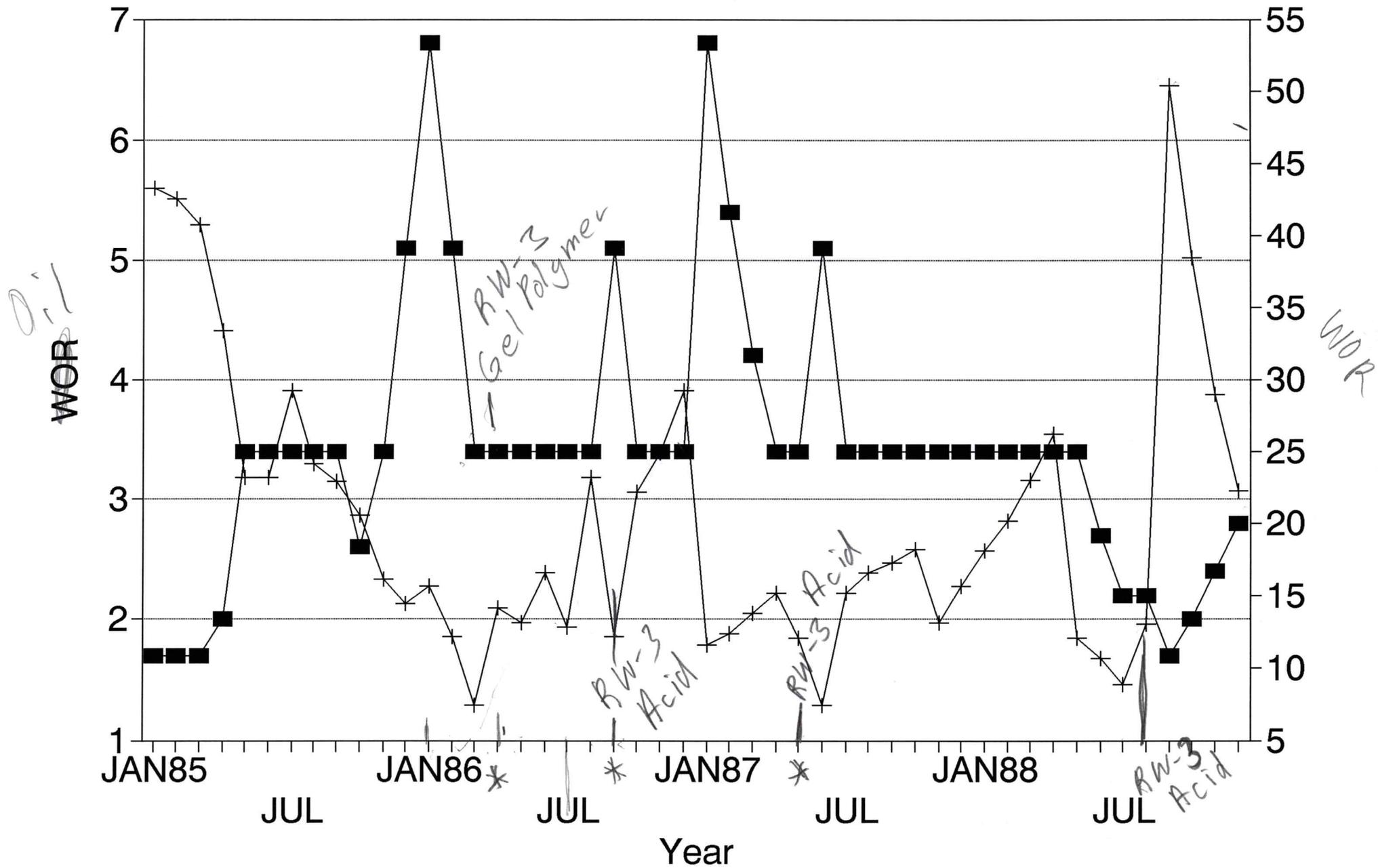


FIGURE A4

RW-3 Injection Well



H-17 Production Well



WELL KW-51 (Date Treated 4-8-86) Size - 80 barrels

The five spot pattern with the injector KW-51 at its center had a positive response to the polymer treatment. This injection well is bounded by the following production wells: H-21, H-10, H-20, O-1, and K-30. Since there was no production data on K-30 it was excluded from the study. Note: Production well H-10 is a common production well with treated pattern HW-31 and production well H-21 is a common production well with treated pattern RW-8. Pattern HW-31 was treated at approximately the same time and pattern RW-8 was treated in Dec. 86.

The oil production for the entire pattern is presented in Figure B1 with a decline rate of 54% prior to the treatment. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 3705 barrels. A plot of water-oil ratio versus time is presented in Figure B2. There was an immediate reduction in WOR following the treatment, however following each acid cleanup the water-oil ratio increased.

The following table presents average bucket tests three months before and after treatment.

Well #	H-10		H-20		H-21		O-1	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	Tr.	80.0	2.5	18.0	10.0	70.0	5.0	35.0
After:	<u>1.5</u>	<u>65.0</u>	<u>2.5</u>	<u>25.0</u>	<u>10.0</u>	<u>50.0</u>	<u>8.0</u>	<u>20.0</u>
Change:	+1.5	-5.0	0.0	+7.0	0.0	-20.0	+3.0	-15.0

Prior to the treatment the injectivity index for KW-51 had been decreasing until March 1985 when it appeared to reach a fairly stable value at 0.08 (b/d/psi). This is presented in Figure B4. Following the treatment the injectivity fell to a value of 0.03 and began a steady increase until February 1987 when it again leveled off at 0.09. Following the treatment the wellhead pressure began to decline and the injection rate began to increase. Three acid clean-up stimulation treatments have been conducted since the treatment and are presented in Figure B4. Each acid cleanup did increase the injectivity index.

WELL RW-7 (Date Treated - 3-26-86) Size - 60 barrels

The five spot pattern with the injector RW-7 at its center had a moderate response to the polymer treatment. The pattern began producing incremental oil in kicks immediately after the treatment. This injection well is bound by the following production wells: K-43, K-45, K-46, and K-47. Both K-46 and K-47 have been shut in since July 1985 and were not included in the study. Note: Production well K-45 is a common production well with treated pattern RW-8 which was treated in December 1986.

The following table presents average bucket tests three months before and after treatment.

Well #	K-43		K-45		K-46		K-47	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	1.7	50.0	2.5	50.0	1.3	25.0*	0.3	10.0*
After:	<u>2.2</u>	<u>30.0</u>	<u>4.0</u>	<u>50.0</u>	<u>SI July 85</u>		<u>SI July 85</u>	
Change:	+0.5	-20.0	1.5	0.0	1.1	23.0	(8 - 87)	

* - Tests ran 9-84

The oil production for the entire pattern is presented in Figure C1 with a decline rate of 51% prior to the treatment as presented. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 915 barrels. A plot of water-oil ratio versus time is presented in Figure C2. Figure C3 present a plot of the five-spot water production prior and after treatment. An unexpected increase in WOR and water production occurred in April 1988.

Since the treatment, injectivity has been continually declining following roughly the same decline rate that it had prior to treatment (See Figure C4). Three acid clean up stimulation treatments have been implemented, each increasing injectivity index and oil production.

WELL RW-11 (Date of Job - 3-22-86) Size - 45 barrels

The five spot pattern with the injector RW-11 at its center had an increase in oil production in response to the polymer treatment. This injection well is bound by production wells K-41 and K-48. K-48 was shut in during the placement of polymer. K-41 was shut in after polymer was detected during placement of treatment.

K-41 showed a kick in oil production immediately following the treatment. Incremental oil production was estimated at 235 barrels. A plot of water oil ratio and oil production as a function of time is presented in Figure D2 and D3 respectively.

The following table presents average bucket tests three months before and after treatment.

Well #	K-41		K-48	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	0.5	30.0	Tr.	10.0
After:	<u>2.5</u>	<u>40.0</u>	<u>0.5</u>	<u>25.0</u>
Change:	+2.0	+10.0	0.5	+15.0

Immediately following the treatment, RW-11 had a decrease in injectivity index which lasted for four months. Figure D4 presents the injectivity index on the injection well. Two acid clean up stimulation treatments have been implemented, each increasing injectivity index.

WELL RW-8 (Date of Job - 12-19-86) Size - 182 barrels

The five spot pattern with the injector RW-8 at its center had a moderate response to the polymer treatment. For this well the treatment was performed in December 1986. This injector is bound by the following production wells: K-44, K-45, and H-21. Note: Production well K-45 is a common production well with treated pattern RW-7 and production well H-21 is a common production well with treated pattern KW-51 which were treated nine months prior to RW-8.

The following table presents average bucket tests three months before and after treatment.

Well #	H-21		K-44		K-45	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	10.0	75.0	3.5	55.0	3.4	60.0
After:	<u>10.0</u>	<u>45.0</u>	<u>2.8</u>	<u>35.0</u>	<u>3.4</u>	<u>40.0</u>
Change:	0.0	-30.0	-0.7	-15.0	0.0	-20.0

As observed from the above table, no immediate increase in oil production response with a reduction in produced water. However in the long term the oil production did respond. The oil production for the entire pattern is presented in Figure EI with a decline rate of 48% prior to the treatment. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 2418 barrels when comparing actual five-spot oil production with the predicted rate from the decline curve. Figure E2 and E3 present the producing water-oil ratio and water production respectively for the five-spot as a function of time.

The injection well RW-8 was recently recompleted in December 1986. The injectivity index for this well has been on a steady decline. The injectivity index is presented in Figure E4. An acid cleanup treatment increased injectivity index and oil production in April 1987.

WELL HW-31 (Date of Job - 4-17-86) Size - 70 barrels

The five spot pattern with the injector HW-31 at its center is bound by the following production wells: H-3, H-5, H-10, and H-9. H-9 has been shut in and was not included in this study. Note: Production Well H-10 is a common production well with treated pattern KW-51 and production well H-9 and H-3 are common production wells with treated pattern HW-1. KW-51 was treated at approximately the same time and HW-1 was treated in September 1987.

The following table presents average bucket tests three months before and after treatment.

Well #	H-10		H-3		H-5	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	Tr.	80.0	2.5	50.0	2.0	15.0
After:	<u>1.5</u>	<u>65.0</u>	<u>2.5</u>	<u>50.0</u>	<u>2.2</u>	<u>10.0</u>
Change:	+1.5	-15.0	0.0	0.0	+2	-5.0

The oil production for the entire pattern is presented in Figure F1. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 1018 barrels when comparing actual five-spot oil production with the predicted rate from the decline curve. A plot of water-oil ratio versus time is presented in Figure F2. Figure F3 present a plot of the five-spot water production prior and after treatment.

Since the treatment the injectivity index has dropped significantly and has remained at a low level as shown in Figure F4. Prior to the treatment the injectivity had been around 0.05(B/D/psi) and immediately following the treatment it fell to around 0.01-0.03. The pressure has been fairly constant on this injector at 800 psi (surface pressure), both before and after the treatment. Therefore, the drop in the injectivity is due to the water injection rate which has fallen. Prior to the treatment injection rates were on the order of 40-50 bbls/day. After the treatment these rates fell to 10-20 bbls/day. This would indicate that the polymer treatment did seal off some of the high perm zones.

Three acid clean up stimulation treatments were implemented with post oil production and injectivity index increasing.

WELL HW-23 (Date of Job - 8-7-87) Size - 199 barrels

The five spot pattern with the injector HW-23 at its center is bound by the following production wells: H-9, H-27, H-28, and H-30.

The following table presents average bucket tests three months before and after treatment.

Well #	H-9		H-27		H-28		H-30	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	1.7	41.3	Tr.	95.0	1.1	95.0	9.8	49.0
After:	<u>1.5</u>	<u>30.0</u>	<u>1.5</u>	<u>65.0</u>	<u>1.1</u>	<u>35.0</u>	<u>8.5</u>	<u>38.0</u>
Change:	-0.2	-11.3	1.5	-30.0	0.0	-60.0	-1.3	-11.0

The oil production for the entire pattern is presented in Figure G1. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 490 barrels when comparing actual five-spot oil production with the predicted rate from the decline curve. A plot of water-oil ratio versus time is presented in Figure G2. Figure G3 present a plot of the five-spot water production prior and after treatment.

Since the treatment the injectivity index has dropped significantly as shown in Figure G4. One acid clean up stimulation treatments was implemented with post injectivity increasing along with oil production.

WELL HW-18 (Date of Job - 8-18-87) Size - 197 barrels

The five spot pattern with the injector HW-18 at its center is bound by the following production wells: H-26, H-27, and H-30.

The following table presents average bucket tests three months before and after treatment.

Well #	H-26		H-27		H-30	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	2.6	18.0	Tr.	95.0	9.8	49.0
After:	<u>2.7</u>	<u>25.0</u>	<u>1.5</u>	<u>65.0</u>	<u>8.5</u>	<u>38.0</u>
Change:	0.1	+6.0	1.5	-30.0	-1.3	-11.0

The oil production for the entire pattern is presented in Figure H1. The five-spot oil production has continued to decline at the decline rate prior to the treatment. A plot of water-oil ratio versus time is presented in Figure H2. Figure H3 present a plot of the five-spot water production prior and after treatment. Both the producing water-oil ratio and water production have increased since the treatment.

Since the treatment the injectivity index has dropped as shown in Figure F4.

WELL HW-1 (Date of Job - 8-14-87) Size - 96 barrels

The five spot pattern with the injector HW-1 at its center is bound by the following production wells: H-1, H-3, H-6, and H-9.

The following table presents average bucket tests three months before and after treatment.

Well #	H-9		H-1		H-3		H-6	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	1.7	41.3	2.4	53.3	1.5	42.0	SI	
After:	<u>1.5</u>	<u>30.0</u>	<u>2.2</u>	<u>39.0</u>	<u>2.6</u>	<u>31.0</u>		
Change:	-0.2	-11.3	-0.2	-14.3	+1.1	-11.0		

The oil production for the entire pattern is presented in Figure I1. Oil production has stabilized, however no large increase has been noted. A plot of water-oil ratio versus time is presented in Figure I2. Figure I3 present a plot of the five-spot water production prior and after treatment.

Since the treatment the injectivity index has dropped significantly as shown in Figure I4. One acid clean up stimulation treatments was implemented with post injectivity not changing.

WELL HW-29 (Date of Job - 7-30-87) Size - 192 barrels

The five spot pattern with the injector HW-29 at its center is bound by the following production wells: O-1, K-36, H-30, and H-26.

The following table presents average bucket tests three months before and after treatment.

Well #	O-1		K-36		H-26		H-30	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	2.7	33.0	Tr.	55.0	2.6	18.0	9.7	51.3
After:	<u>3.4</u>	<u>44.0</u>	<u>0.9</u>	<u>31.0</u>	<u>2.7</u>	<u>24.0</u>	<u>7.7</u>	<u>38.7</u>
Change:	0.7	+11.0	0.9	-24.0	0.1	+6.0	-2.0	12.6

The oil production for the entire pattern is presented in Figure J1. It is clear from this plot that the gel treatment has not effected the pattern's oil production significantly, however production well K-36 has been reported to show an increase; in the past, this well made only a trace of oil. A plot of water-oil ratio versus time is presented in Figure J2. Figure J3 present a plot of the five-spot water production prior and after treatment.

Since the treatment the injectivity index has dropped significantly as shown in Figure J4. Two acid clean up stimulation treatments were implemented with post injectivity increasing alittle.

WELL KW-6 (Date of Job - 6-23-87) Size - 188 barrels

The five spot pattern with the injector KW-6 at its center is bound by the following production wells: H-13, H-14, H-15, and K-39.

The following table presents average bucket tests three months before and after treatment.

Well #	H-13		H-14		H-15		K-39	
	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>	<u>Oil</u>	<u>Water</u>
Before:	1.7	30.0	2.7	50.0	Tr.	30.0	1.5	20.0
After:	<u>4.0</u>	<u>50.0</u>	<u>3.8</u>	<u>40.0</u>	<u>6.8</u>	<u>16.0</u>	<u>2.2</u>	<u>35.0</u>
Change:	+2.3	+20.0	1.1	-10.0	6.8	-14.0	+0.7	+15.0

The oil production for the entire pattern is presented in Figure K1. It is clear from this plot that the gel treatment did have some effect on the pattern's production. Incremental oil was estimated to be 2315 barrels when comparing actual five-spot oil production with the predicted rate from the decline curve. Production well H-15 was shut in from 6-85 thru 7-87 and the bucket test prior to treatment was a 1983 test. A plot of water-oil ratio versus time is presented in Figure K2. Figure K3 present a plot of the five-spot water production prior and after treatment. Water production has decreased.

Since the treatment the injectivity index has dropped significantly as shown in Figure K4. Two acid clean up stimulation treatments were implemented with post injectivity increasing very little.

ECONOMICS

Total polymer solution injected for the eleven treatments was 1363 barrels or 2384 pounds of polymer. When using the incremental oil number of 8837 barrels calculated from the total treated patterns decline curve, 3.7 barrels of incremental oil per pound polymer have been produced and climbing. With an assumption that one barrel of injected polymer costs \$10.00 which includes service and chemical costs, each incremental barrel of oil costs \$1.54.

CONCLUSIONS:

1. Of the eleven treated pattern, eight have shown a response in incremental oil.
2. When conducting decline curve analysis on all the treated patterns, incremental oil is estimated at 8837 barrels which is 3.7 incremental barrels of oil per pound of polymer placed.
3. Small acid cleanup treatments have increased injectivity index and have been a factor in improved incremental oil after the gel treatments.
4. Producing water-oil ratios are continuing to increase on most of the treated patterns. In the RW-3 case, producing water-oil ratio increased after each acid cleanup.
5. Oil production trends from bucket tests and battery show good comparison.

RECOMMENDATIONS:

1. Continue implementing gel polymer treatments in channelled patterns.
2. Continue to improve water quality when possible. Wellbore skin is definitely a problem since injectivity index is improving with each acid cleanup.
3. Increase size of acid stimulation and experiment with mutual solvents to increase brine permeability at wellbore.

POSSIBLE TREATMENT DESIGN

1. Establish injectivity with 15% HCL. Inject 25-50 gallons of acid per perforated foot. No less than half the tubing volume. *clay stabilizer*
2. Inject mud acid (3% HF, 12% HCL) immediately after the preflush. (50 gallons of mud acid per perforated foot)
3. Inject a 25 gallon per perforated foot afterflush of 10% EGMBE in a 15% HCL solution. This afterflush acts as a spacer to prevent contact between salt water and HF present in the mud acid.

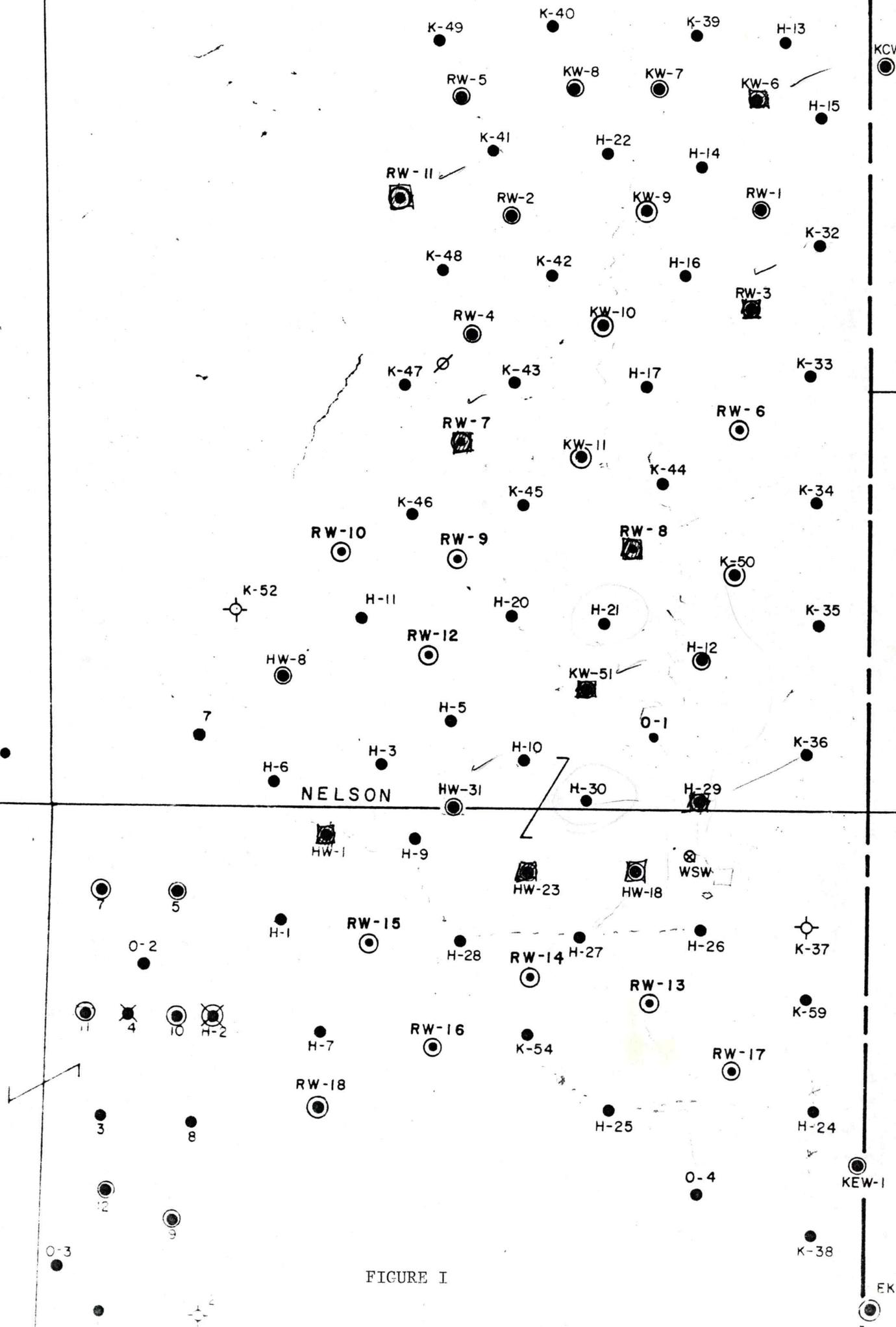


FIGURE I

NELSON LEASE OIL PRODUCTION

ALL TREATED PATTERNS

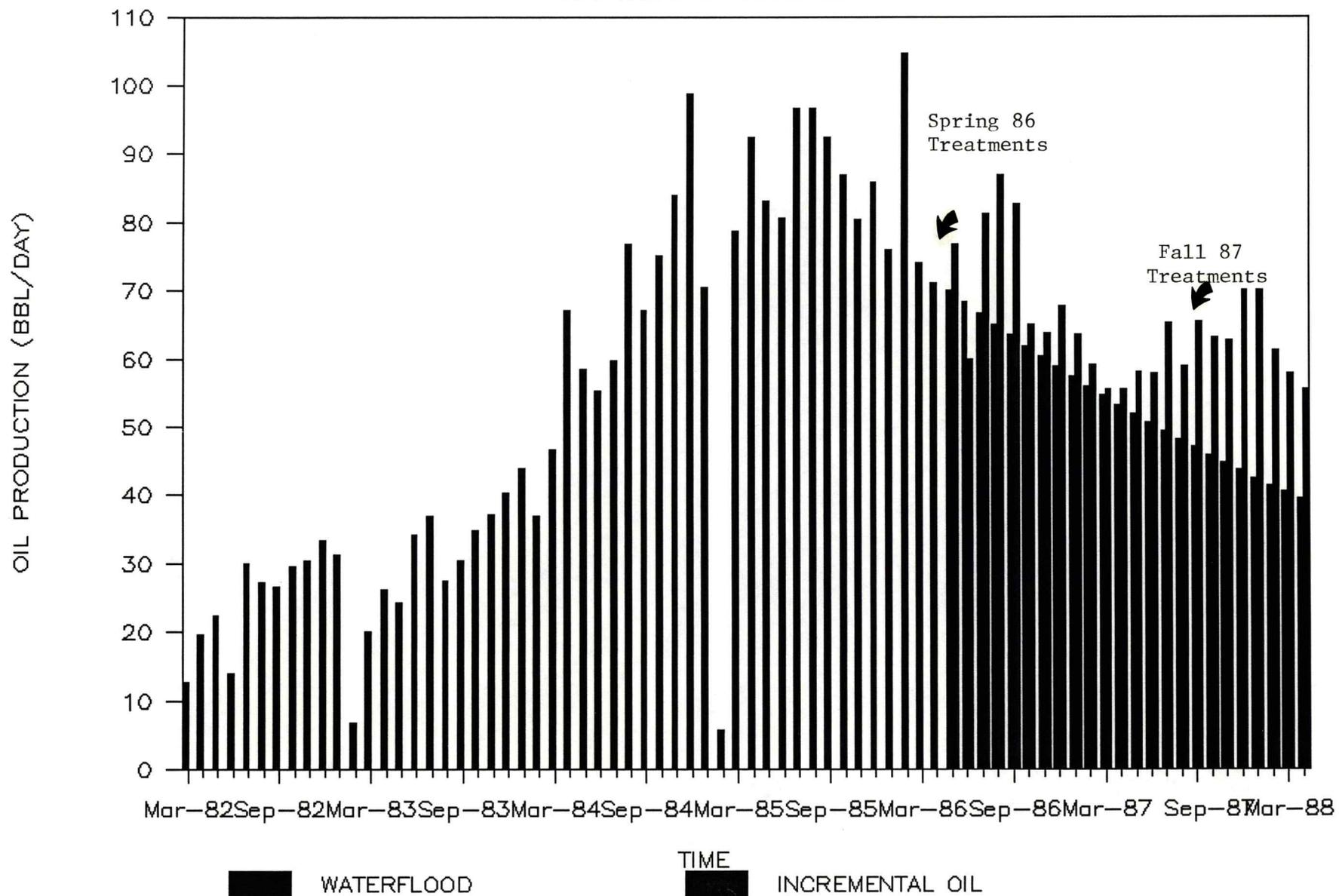


FIGURE II

NELSON LEASE WATER-OIL RATIO

ALL TREATED PATTERNS

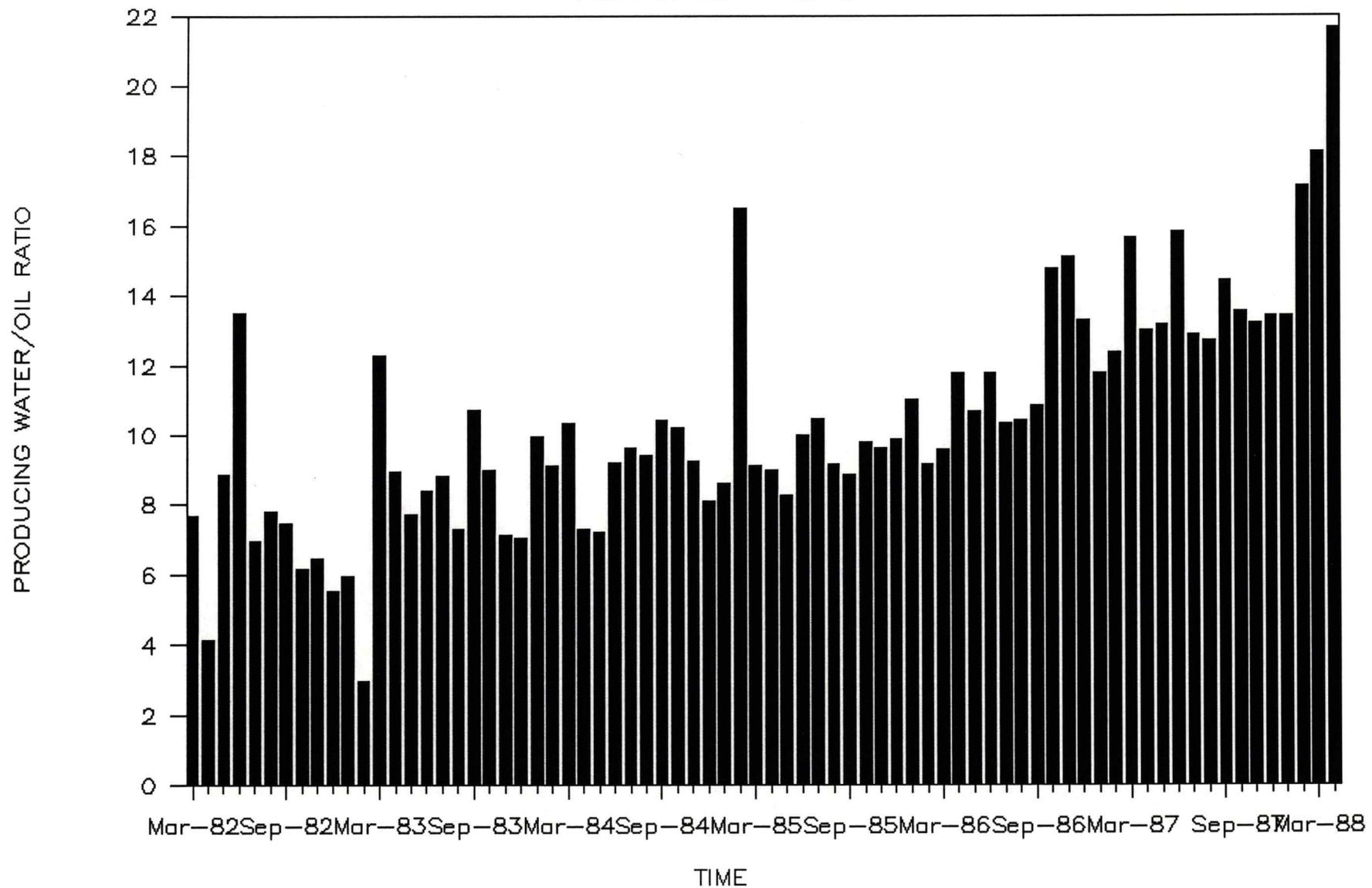


FIGURE III

NELSON LEASE OIL PRODUCTION

DATA FROM BATTERY

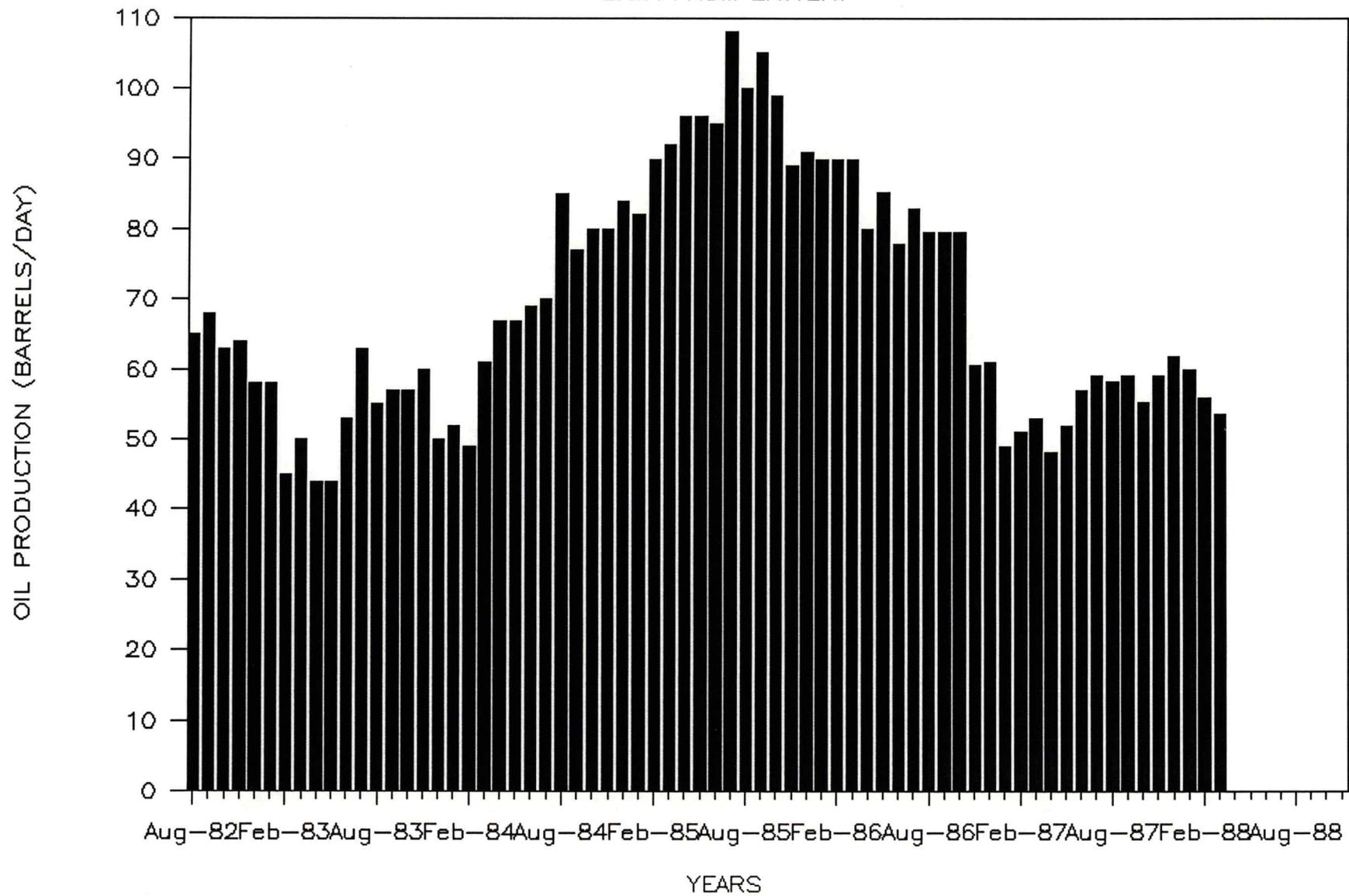


FIGURE IV

NELSON LEASE WATERFLOOD

DATA FROM BATTERY

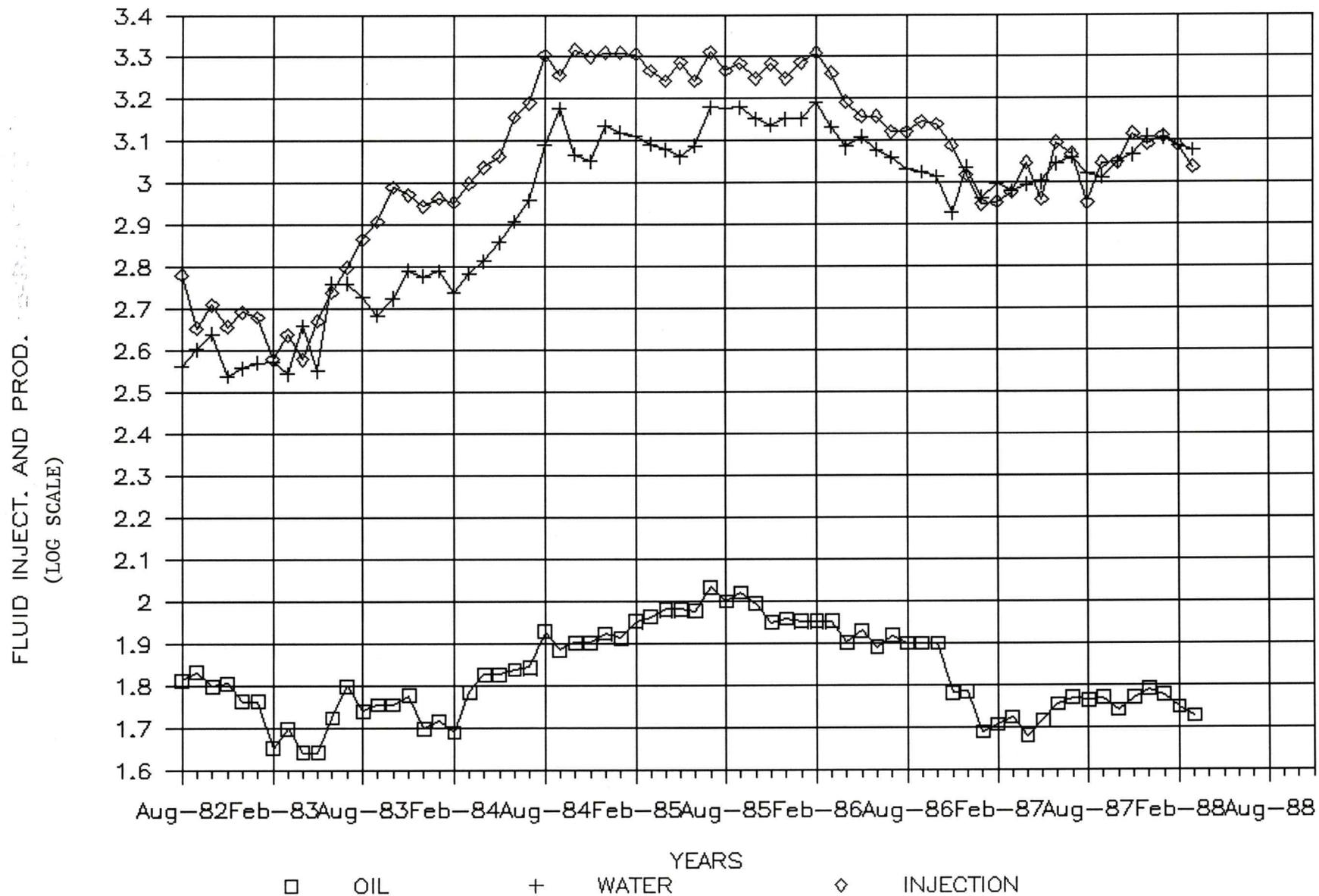


FIGURE V

NELSON LEASE PRODUCING WATER-OIL RATIO

DATA FROM BATTERY

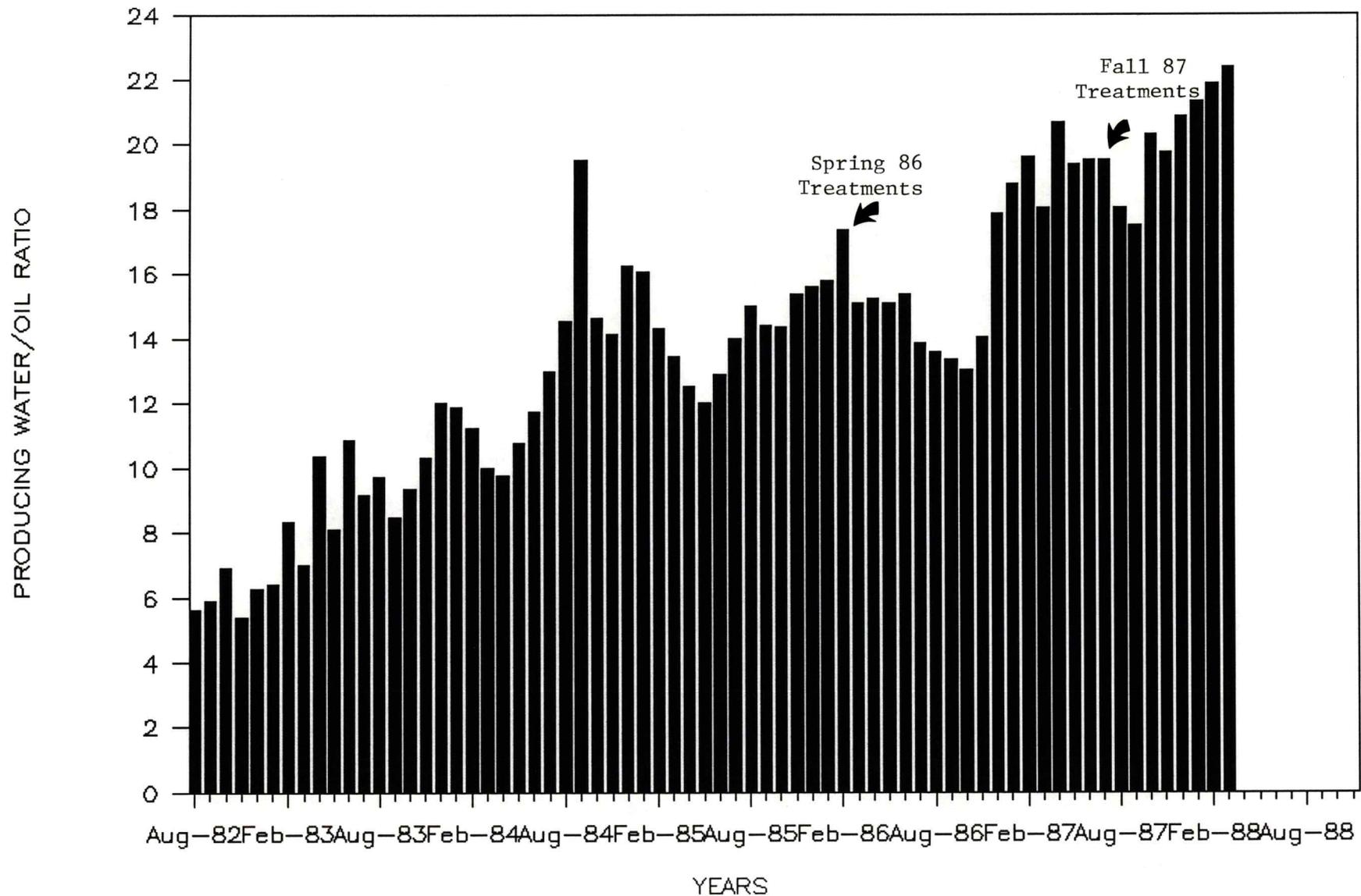


FIGURE VI

NELSON LEASE WATERFLOOD

DATA FROM BATTERY

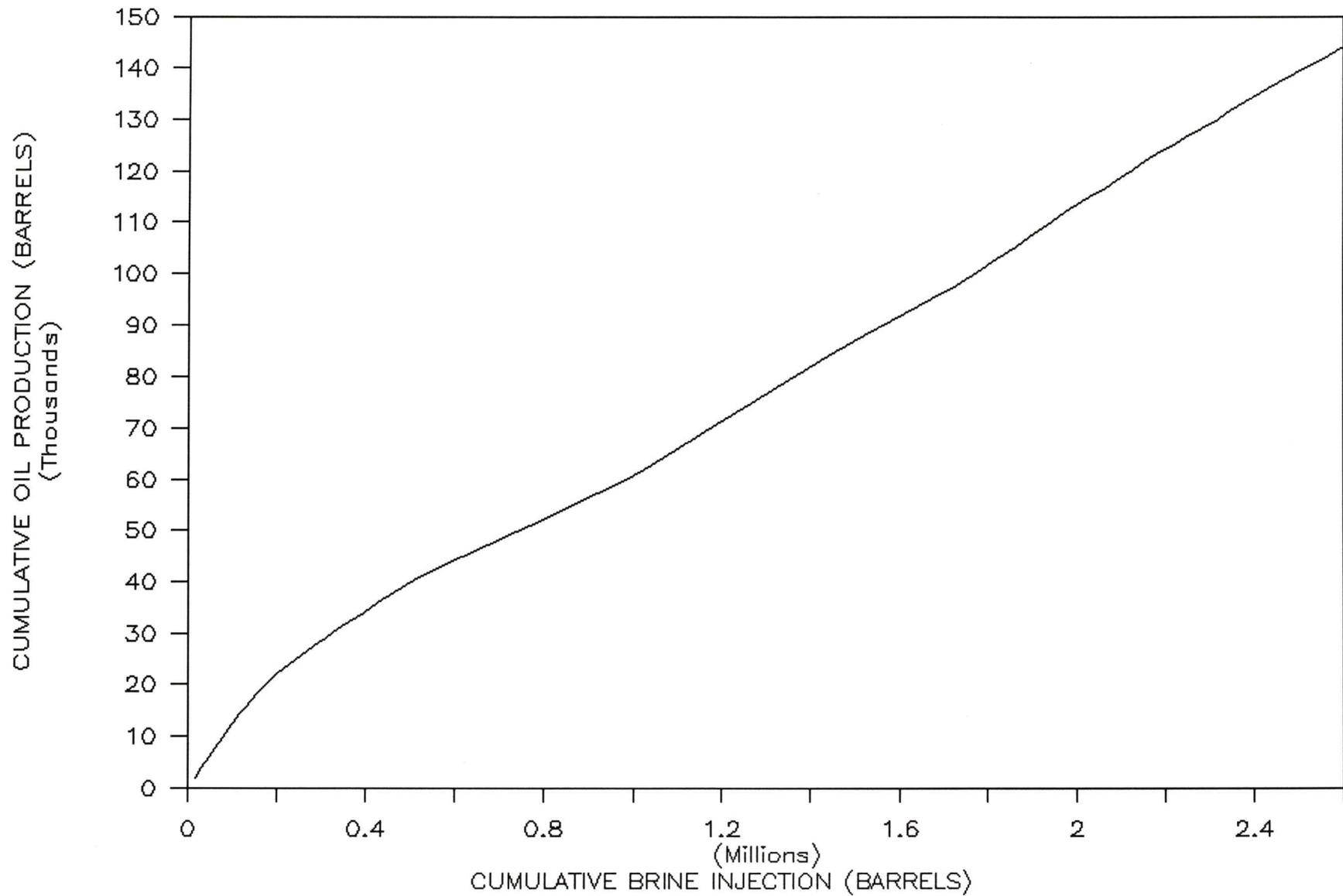
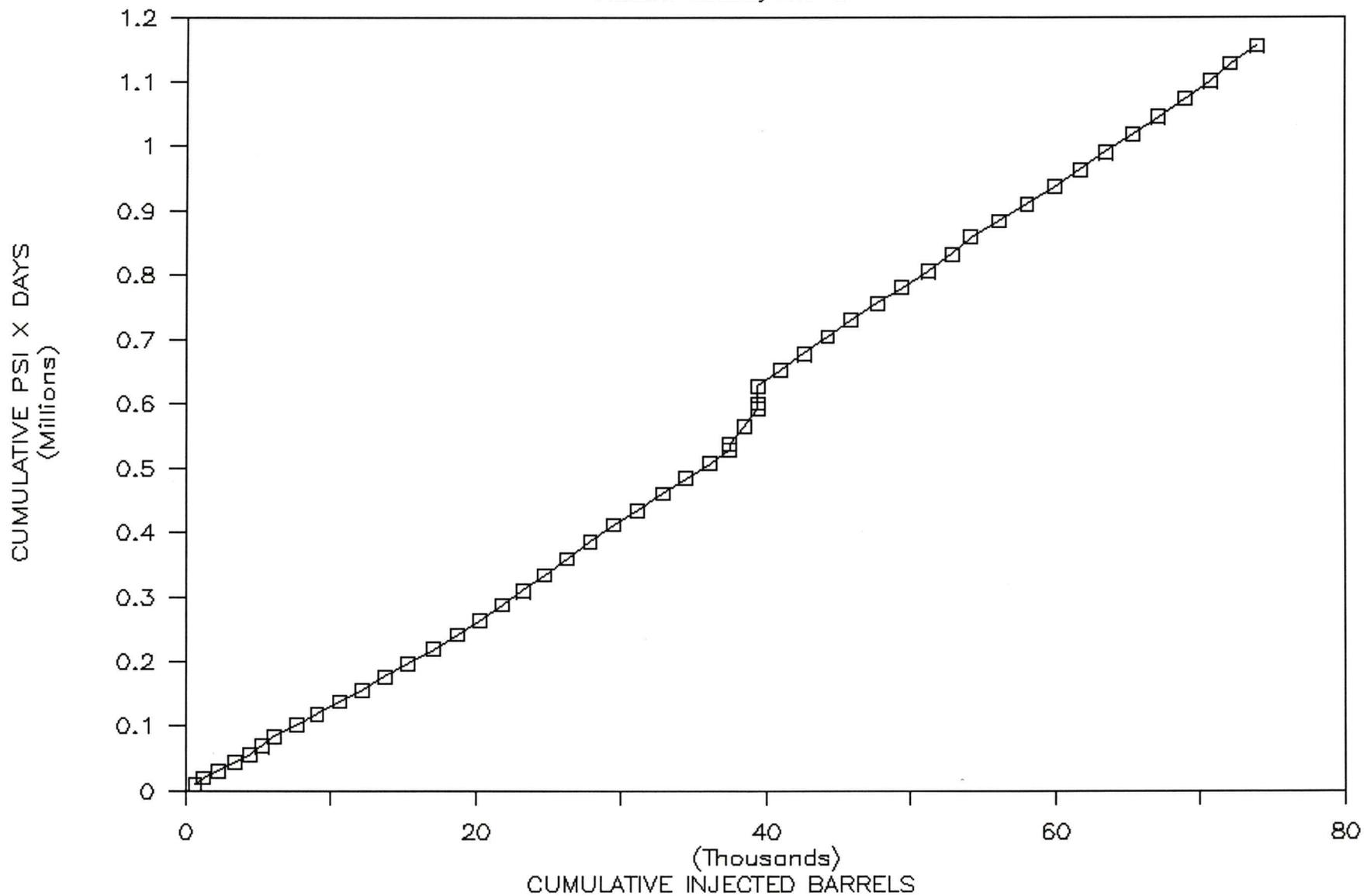


FIGURE VII

HALL PLOT

Nelson Lease, RW-3



GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, KW-51 five spot

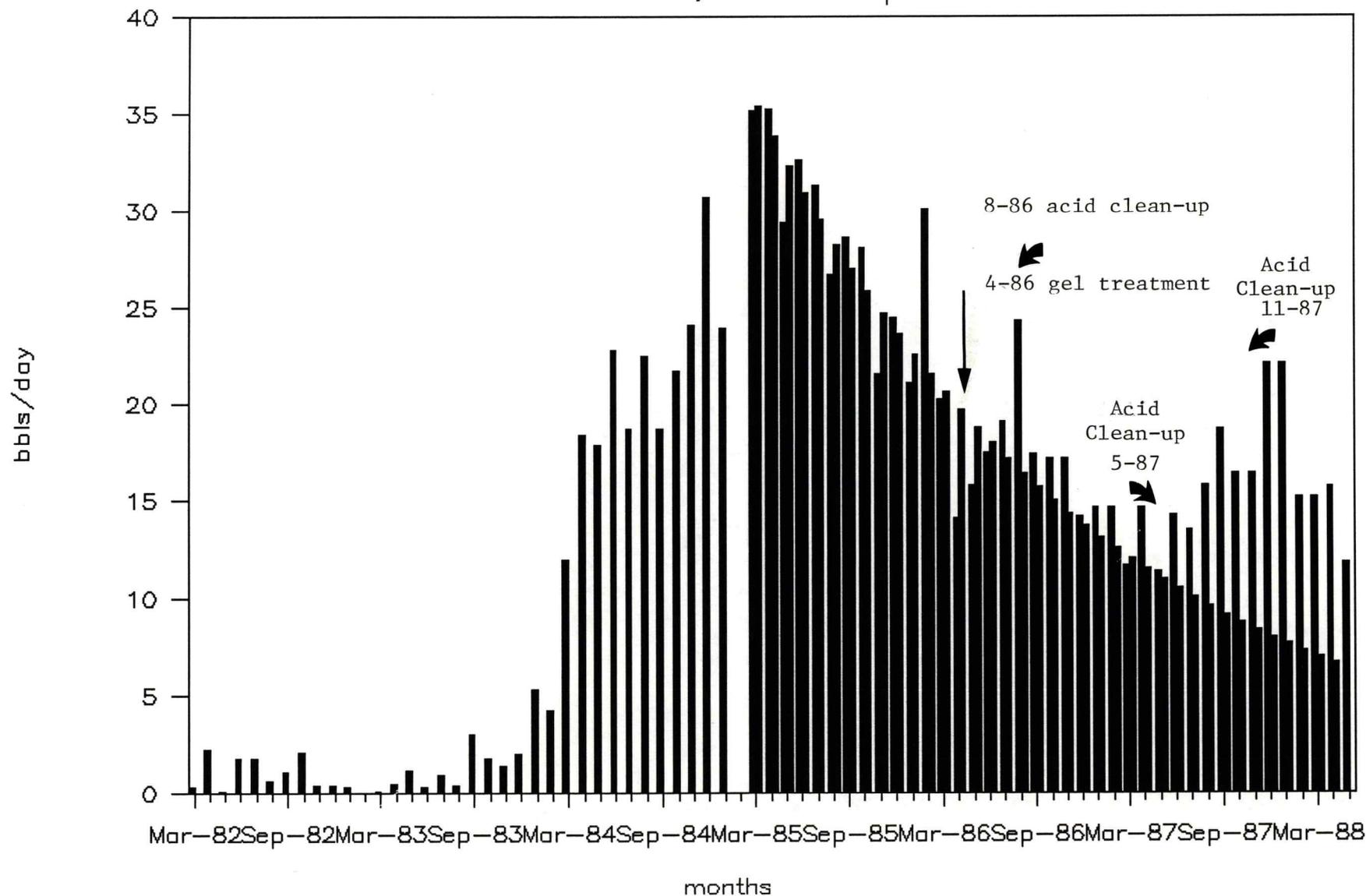


FIGURE B1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, KW-51 five spot

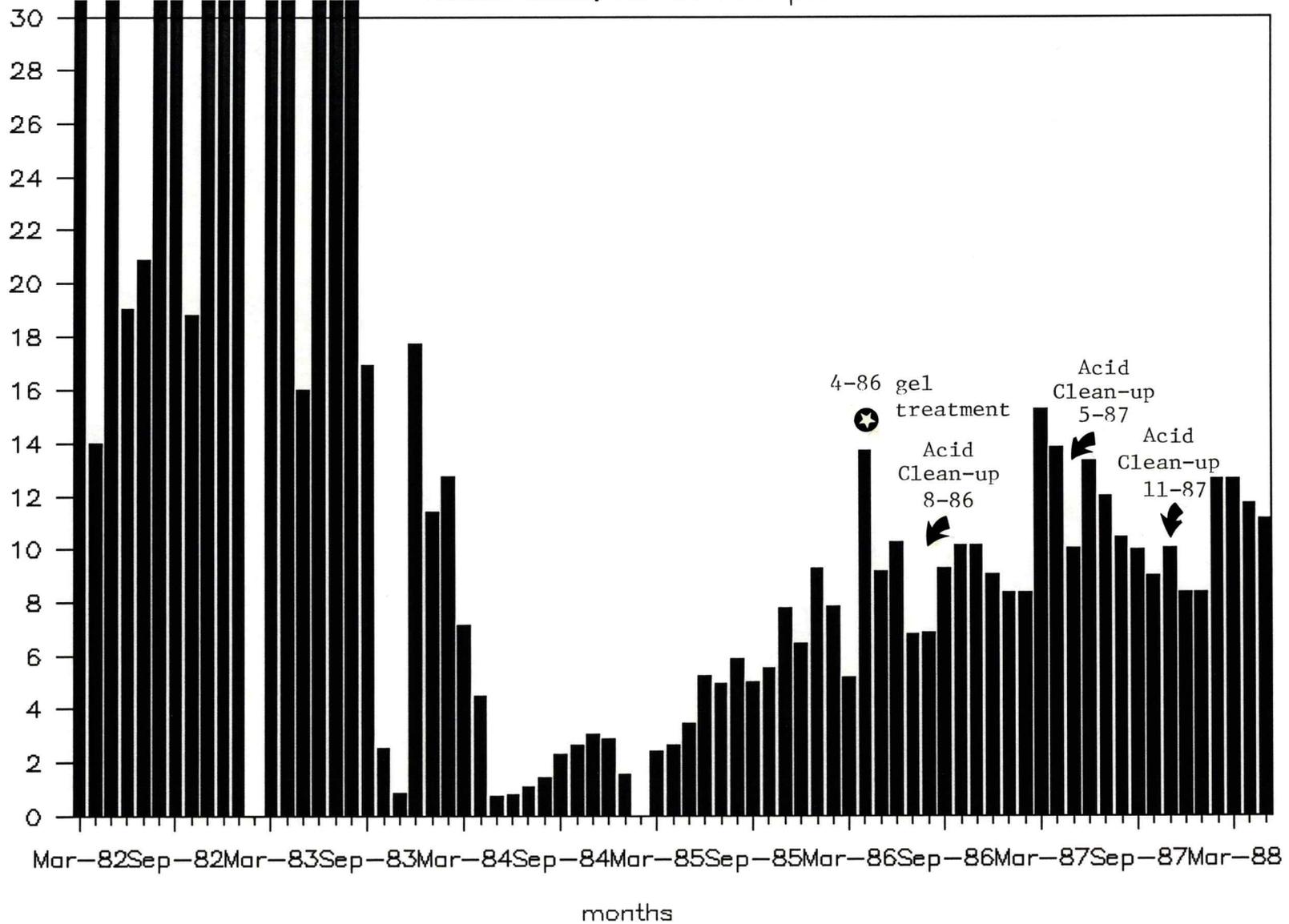


FIGURE B2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, KW-51 FIVE SPOT

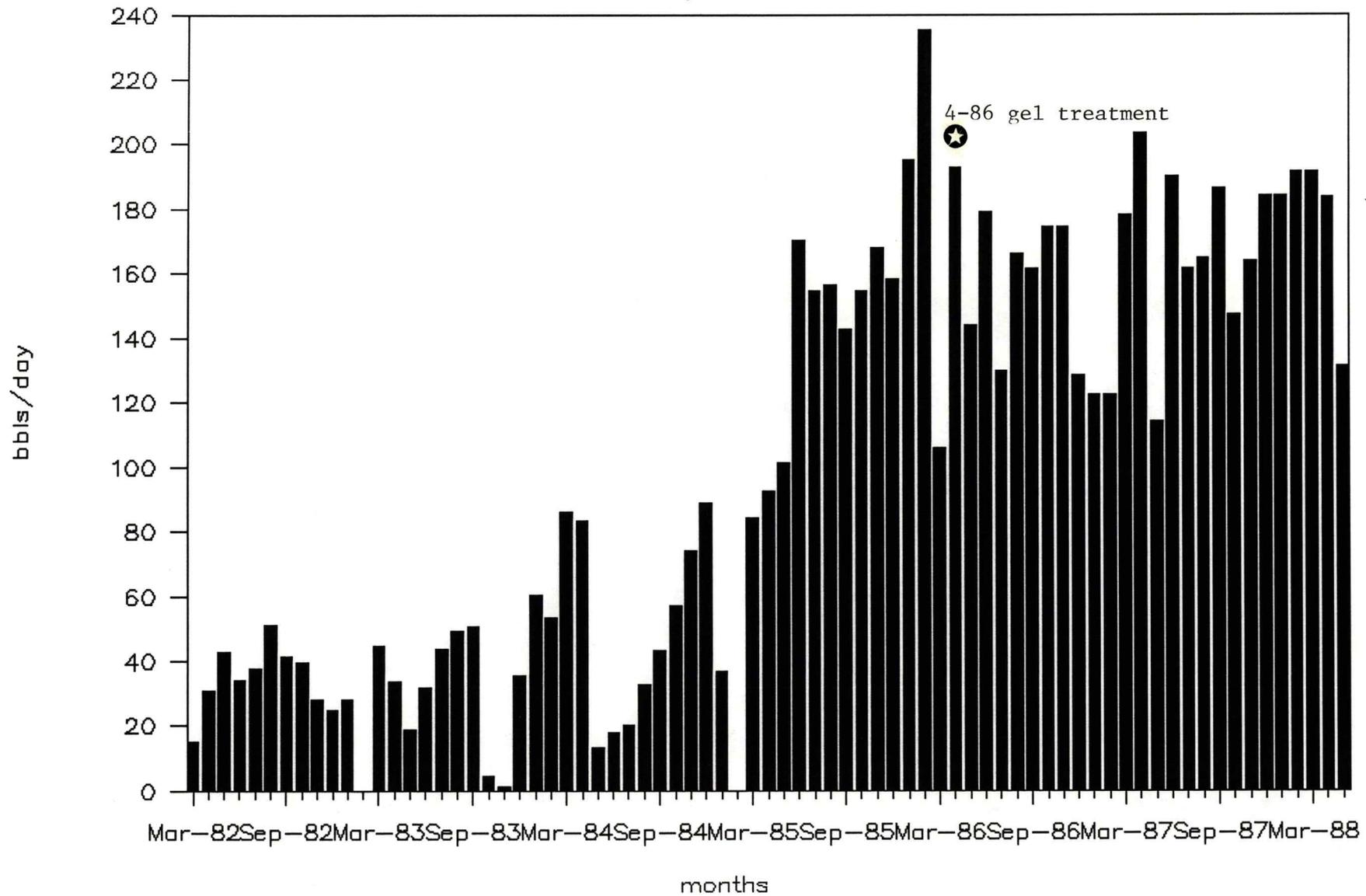


FIGURE B3

GRAPH OF INJECTIVITY INDEX VS. TIME

Nelson Lease: KW-51

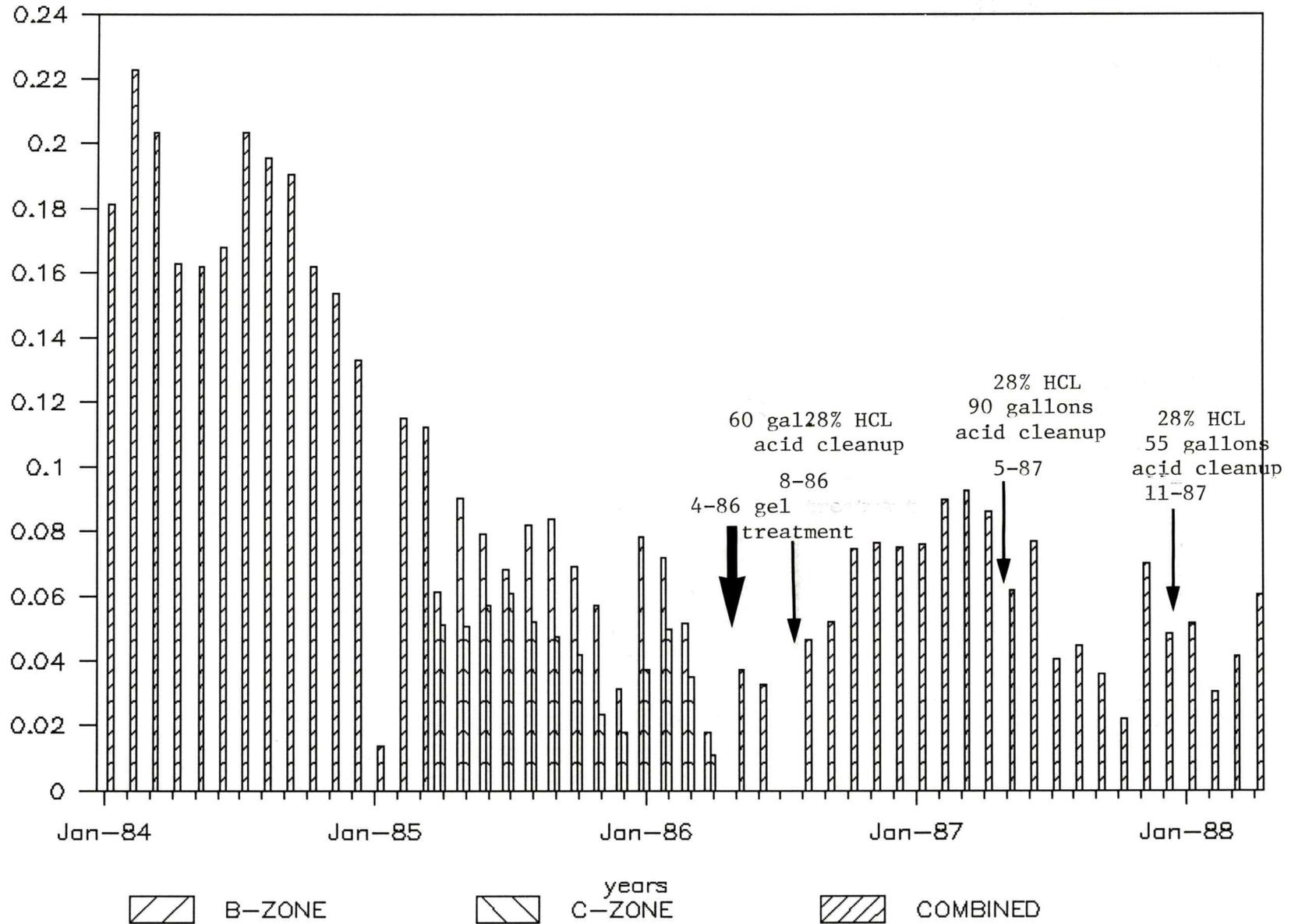


FIGURE B4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, RW-7 five spot

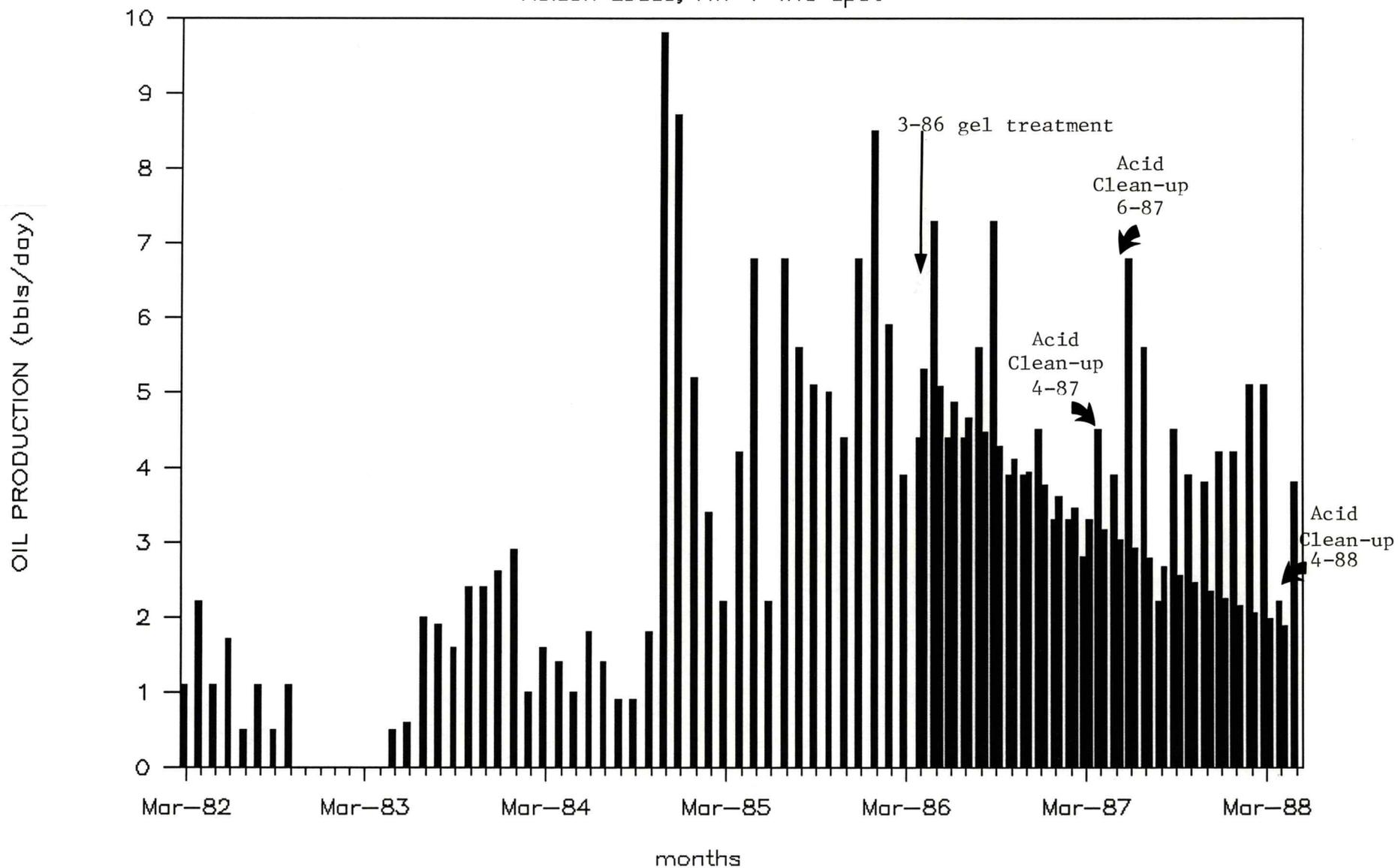


FIGURE C1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, RW-7 five spot

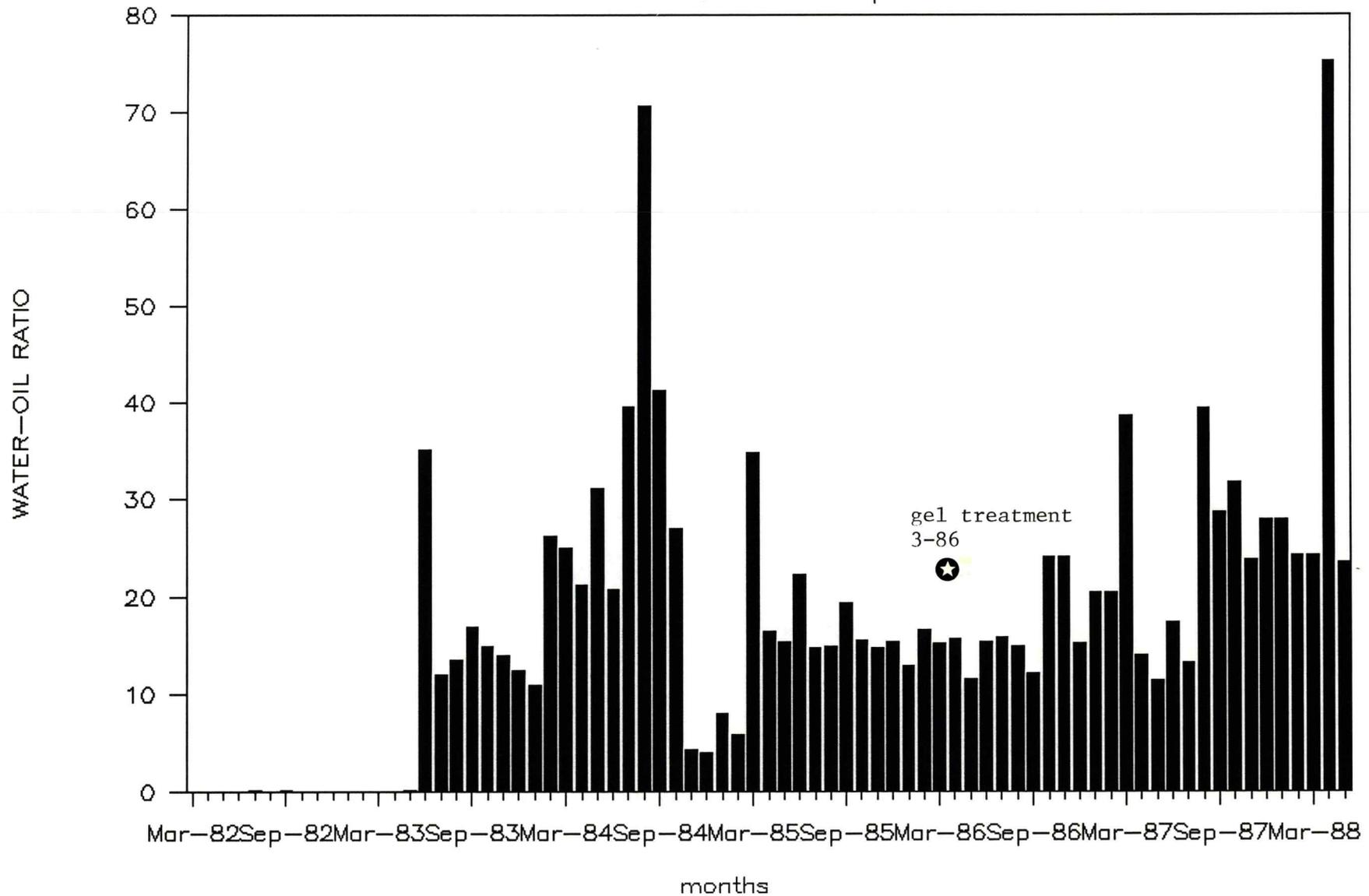


FIGURE C2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, RW-7 five spot

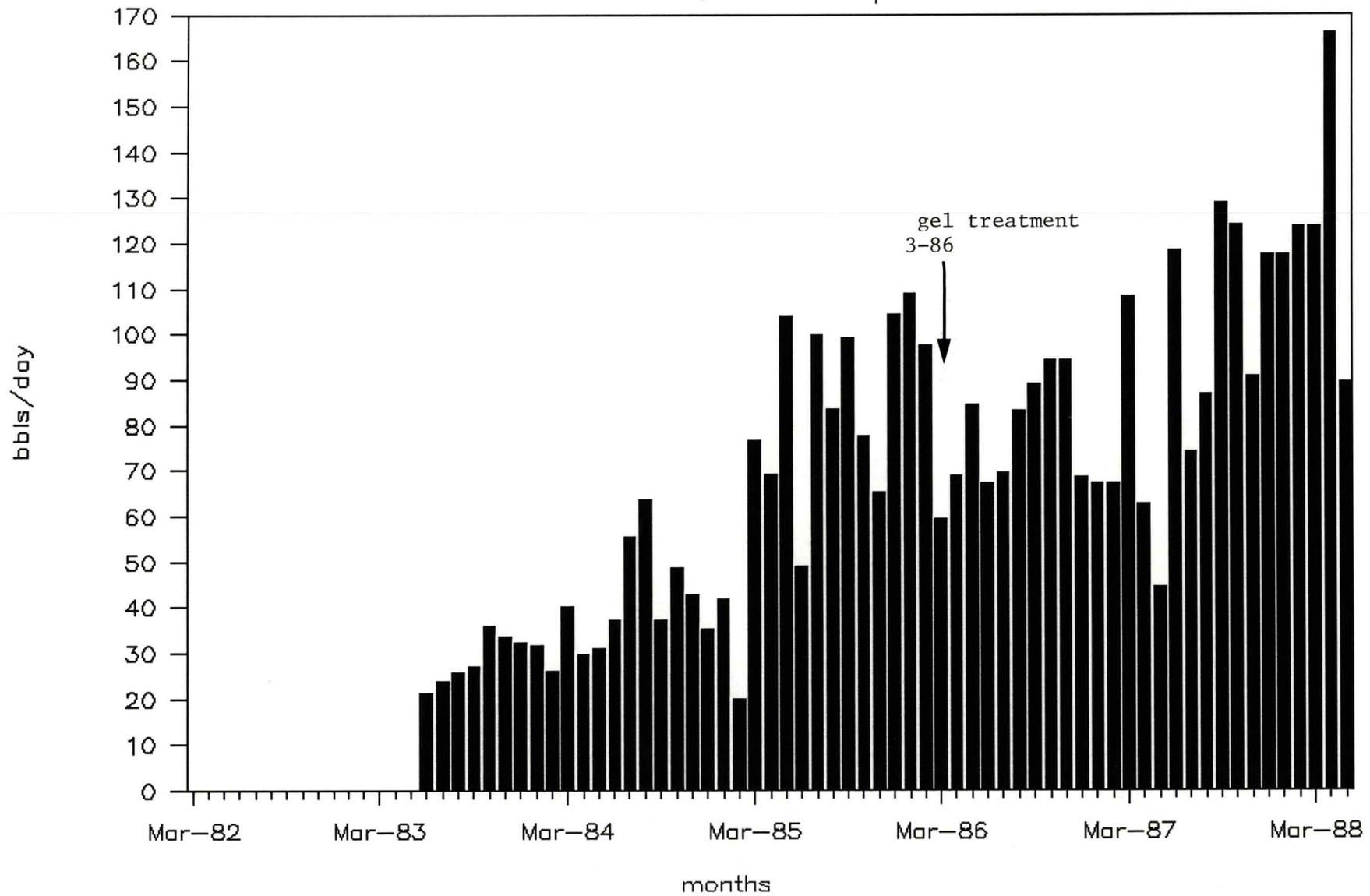


FIGURE C3

INJECTIVITY INDEX VS. TIME

RW-7

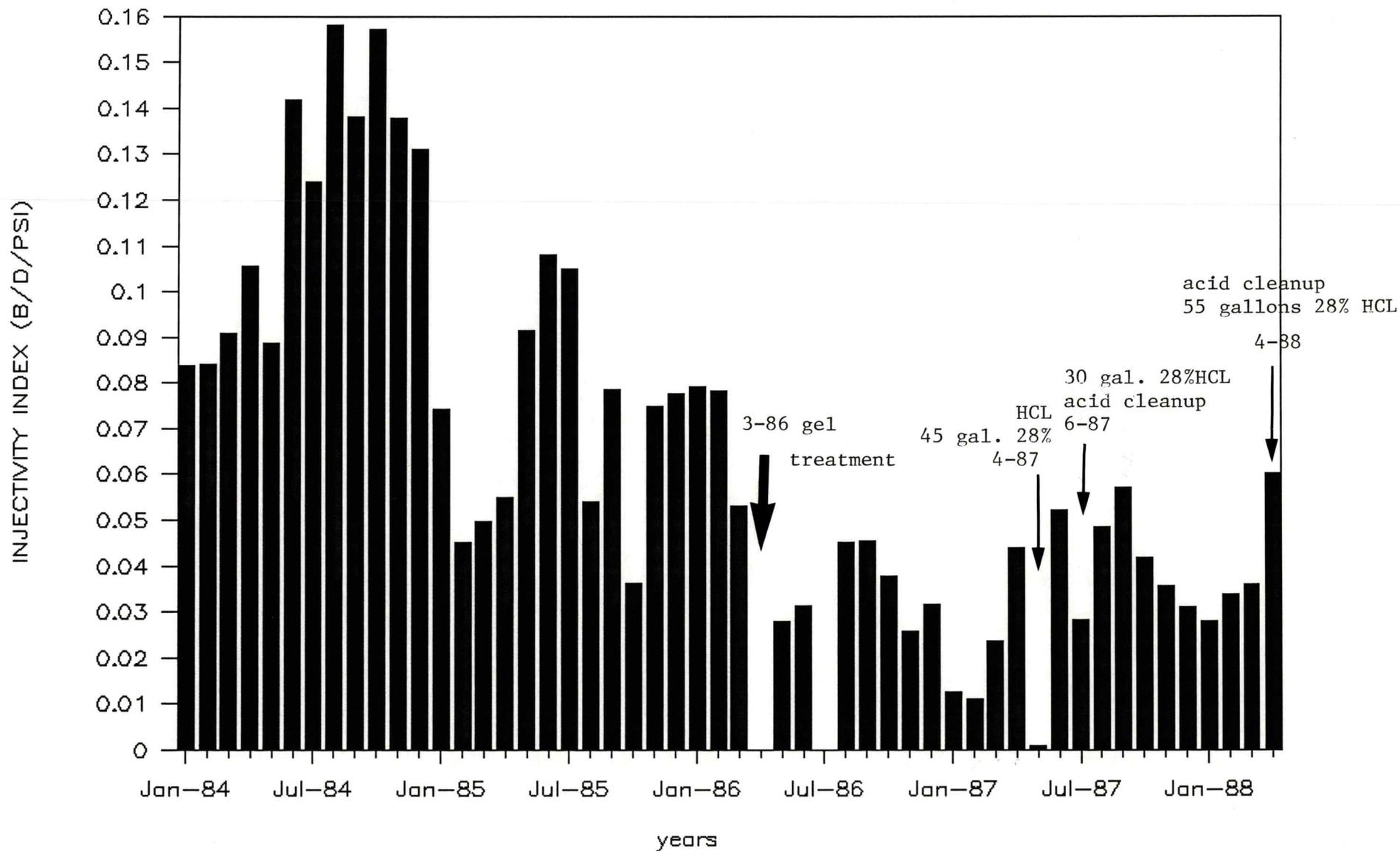


FIGURE C4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, #K-41

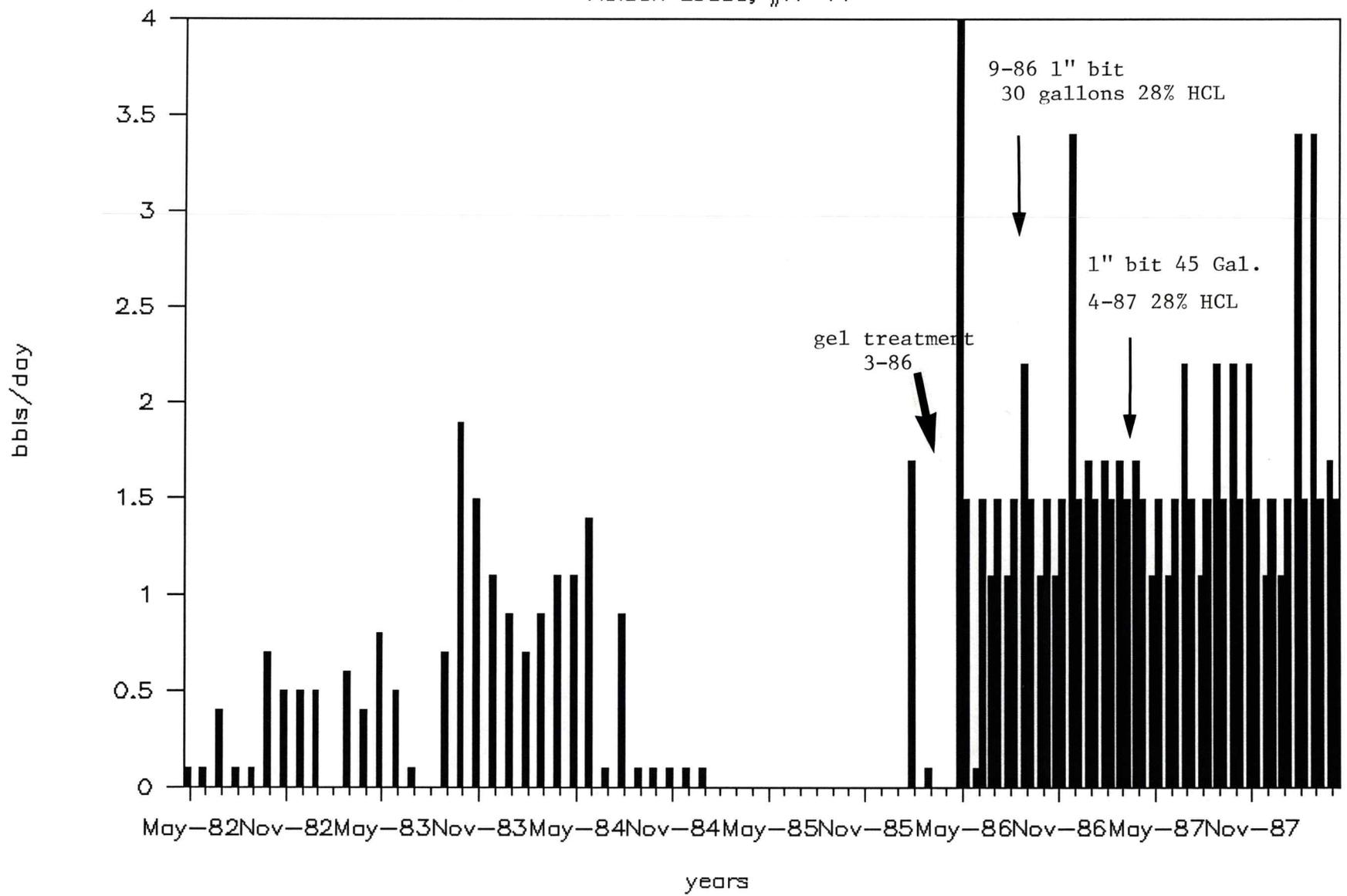


FIGURE D1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, #K-41

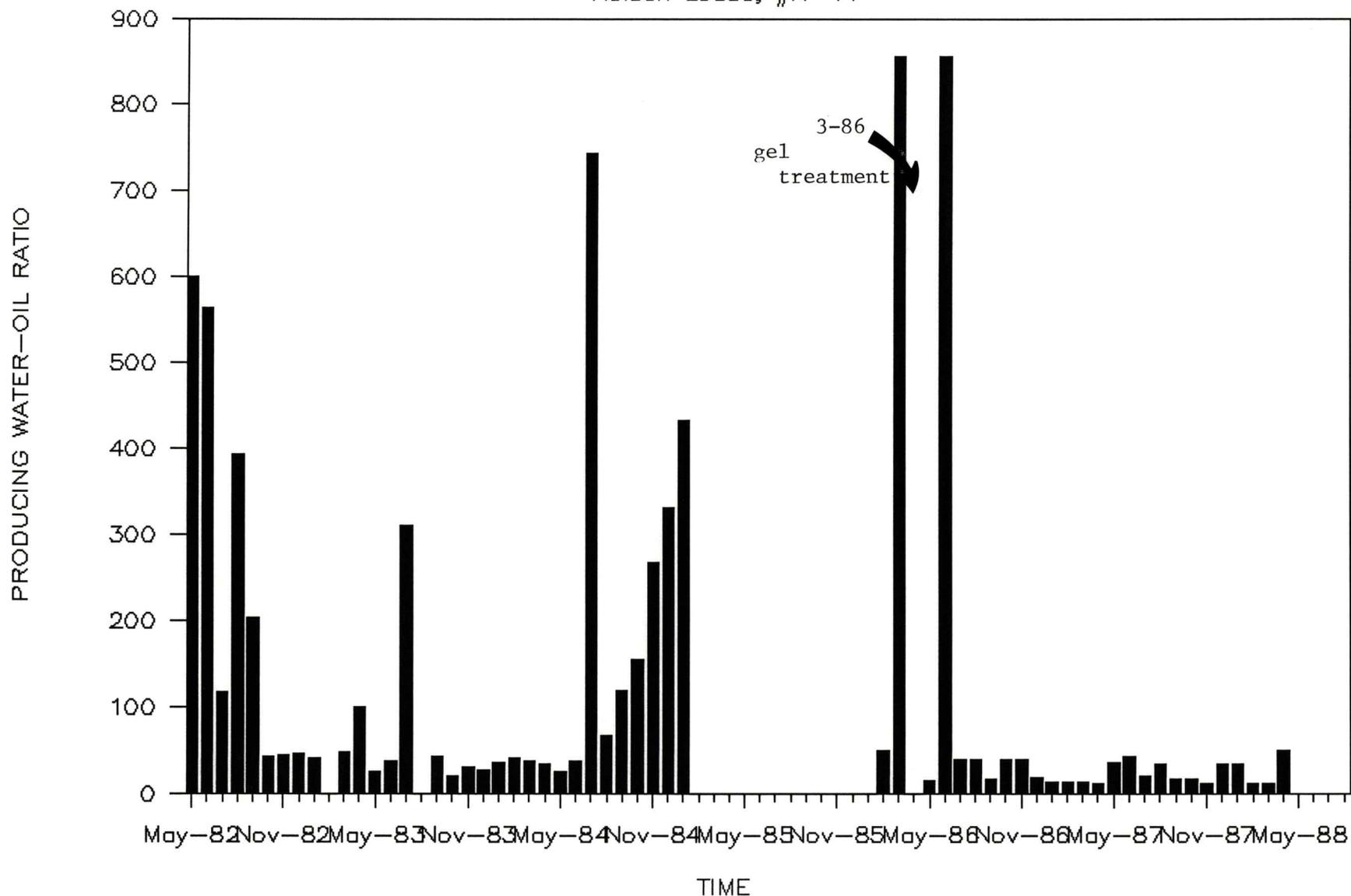


FIGURE D2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, #K-41

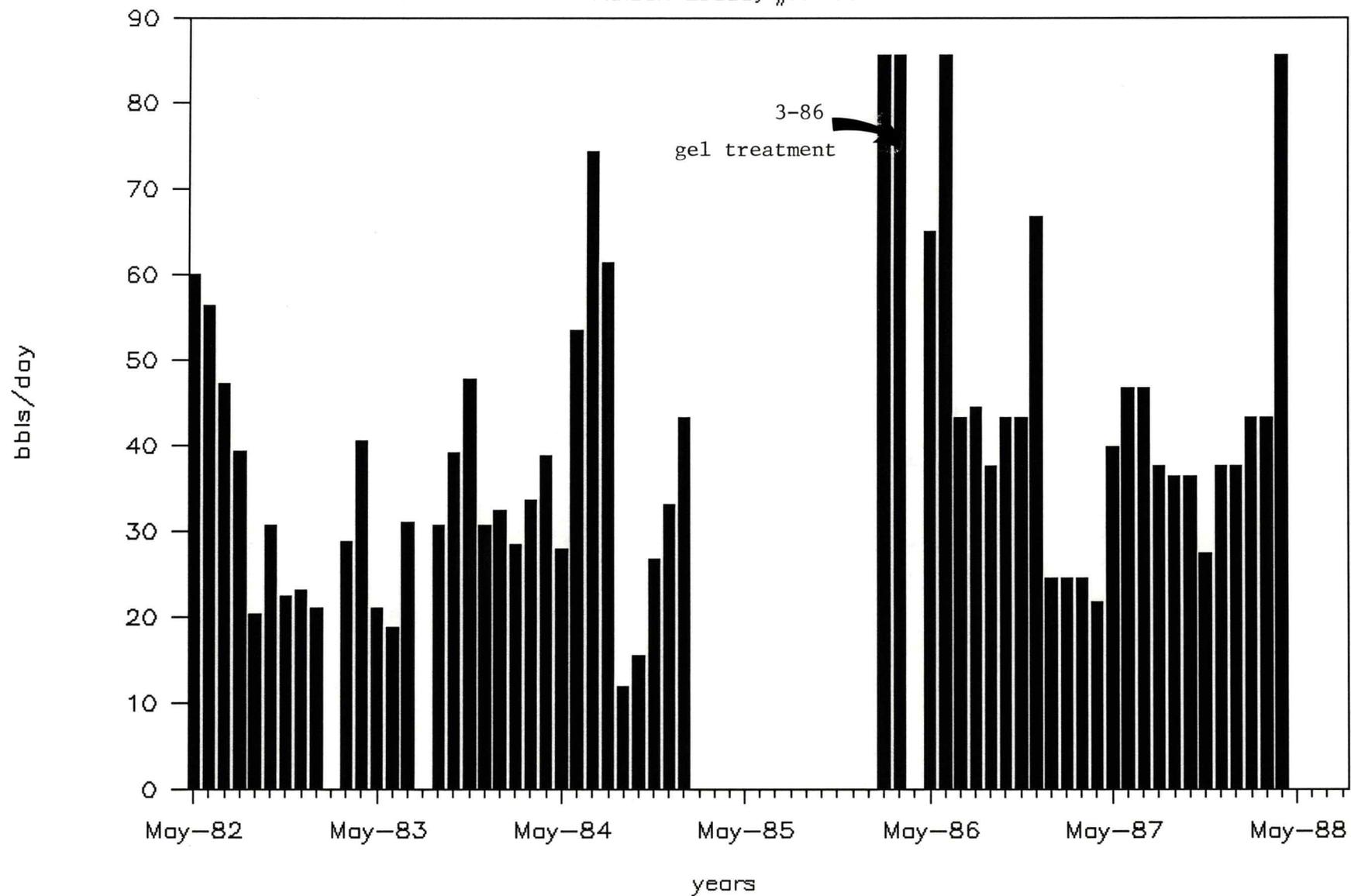


FIGURE D3

GRAPH OF THE INJECTIVITY RATIO VS. TIME

RW-11

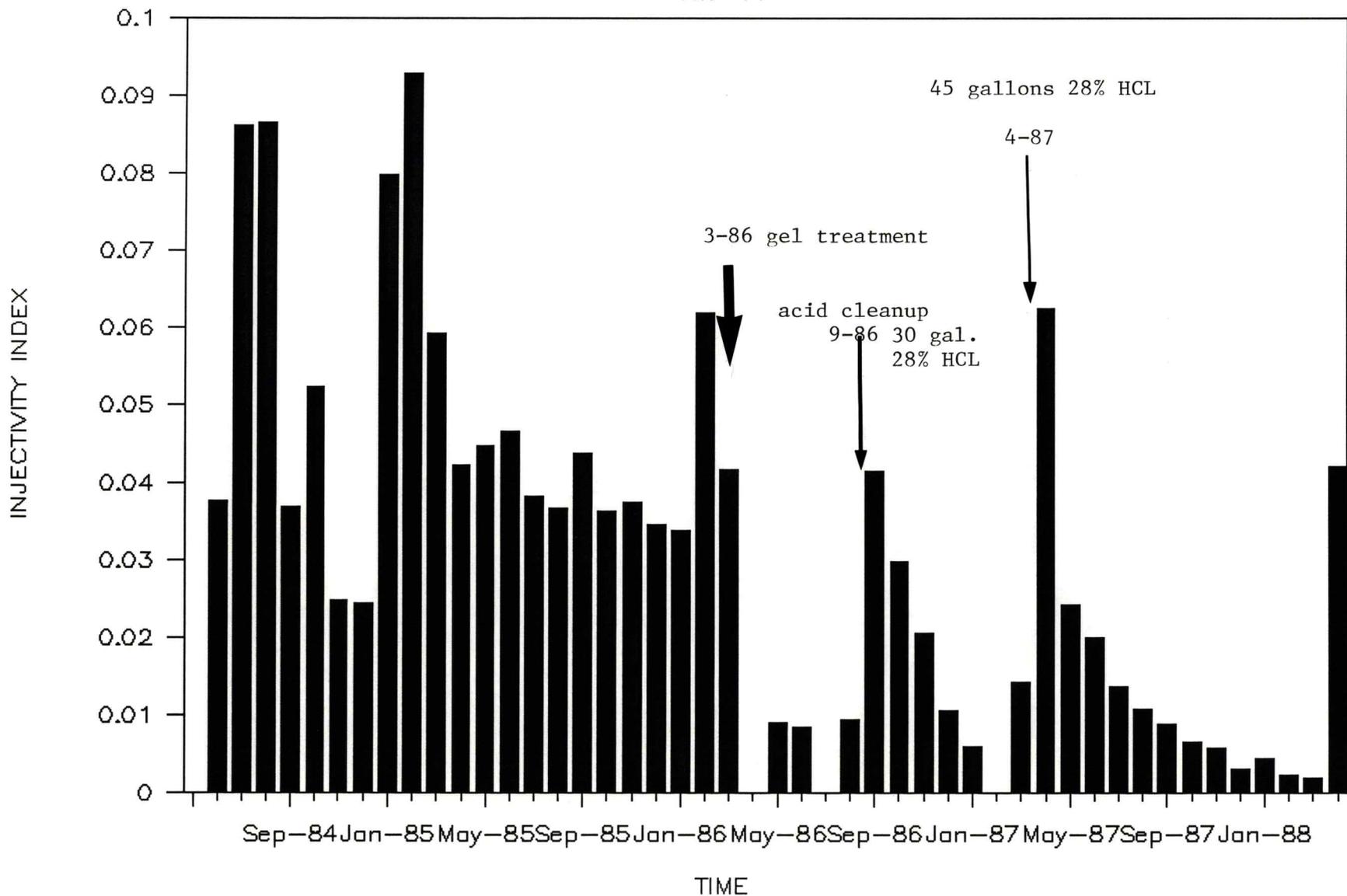
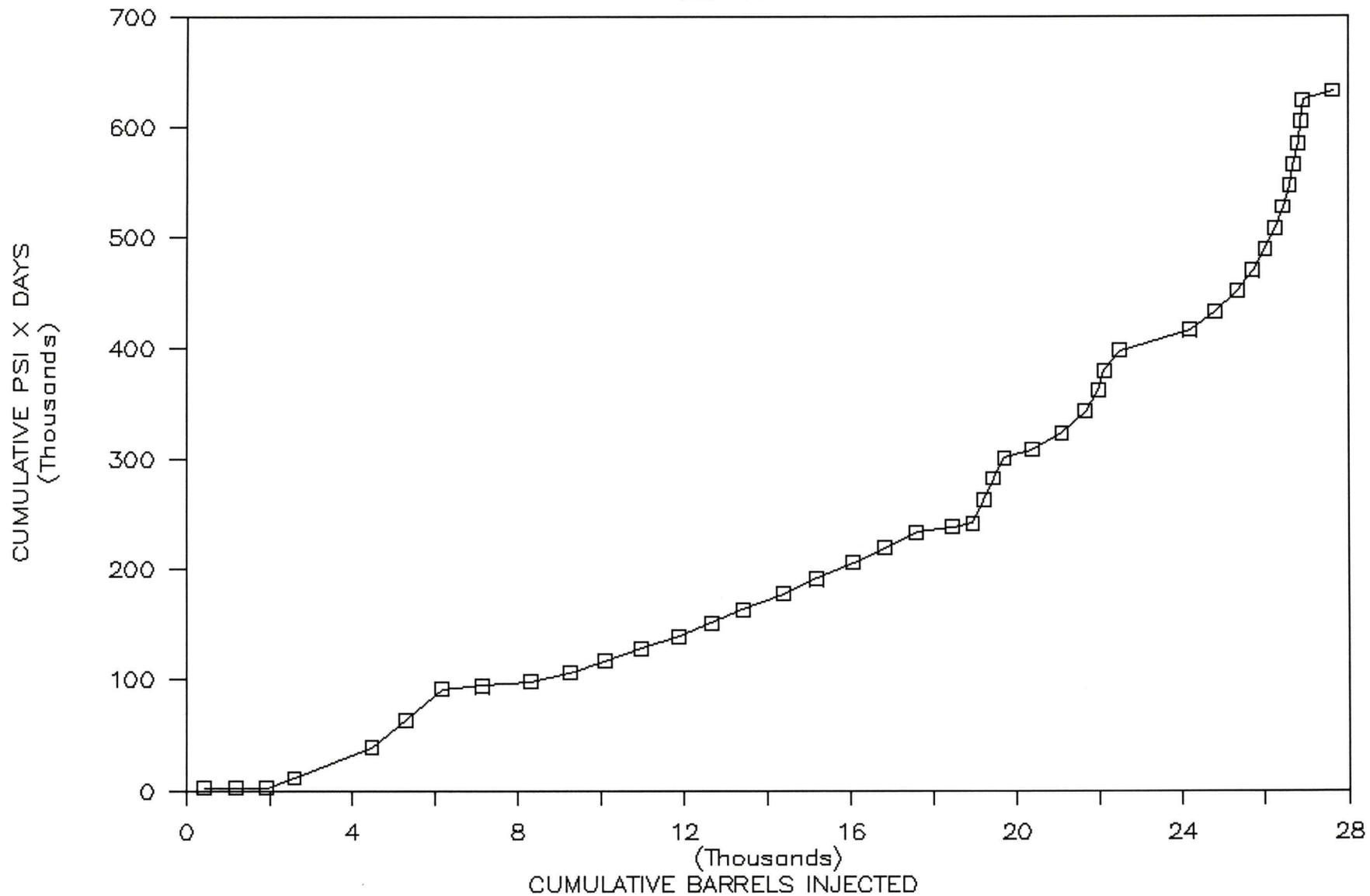


FIGURE D4

HALL PLOT

RW-11



GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, RW-8 five spot

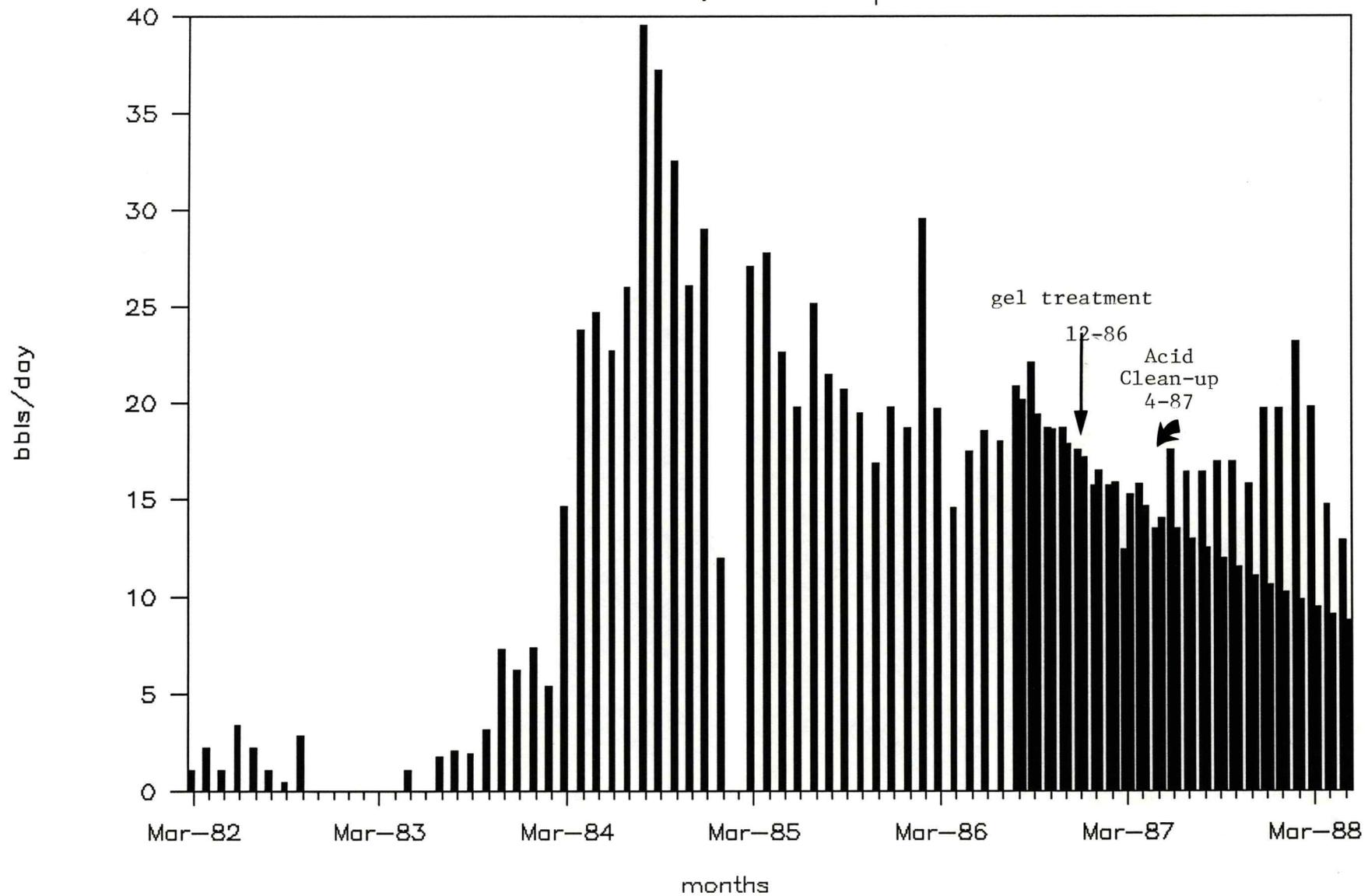


FIGURE E1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, RW-8 five spot

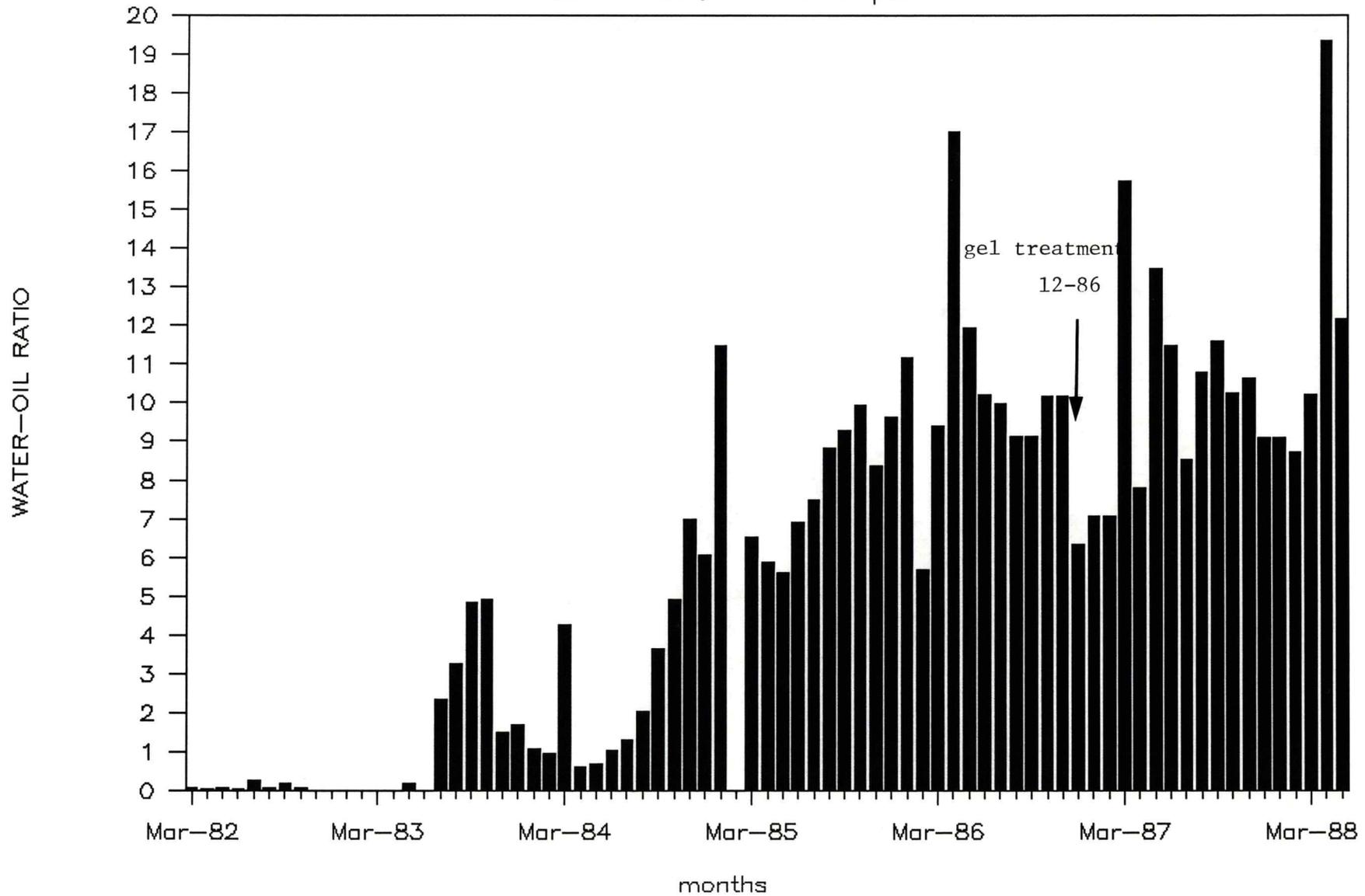


FIGURE E2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, RW-8 five spot

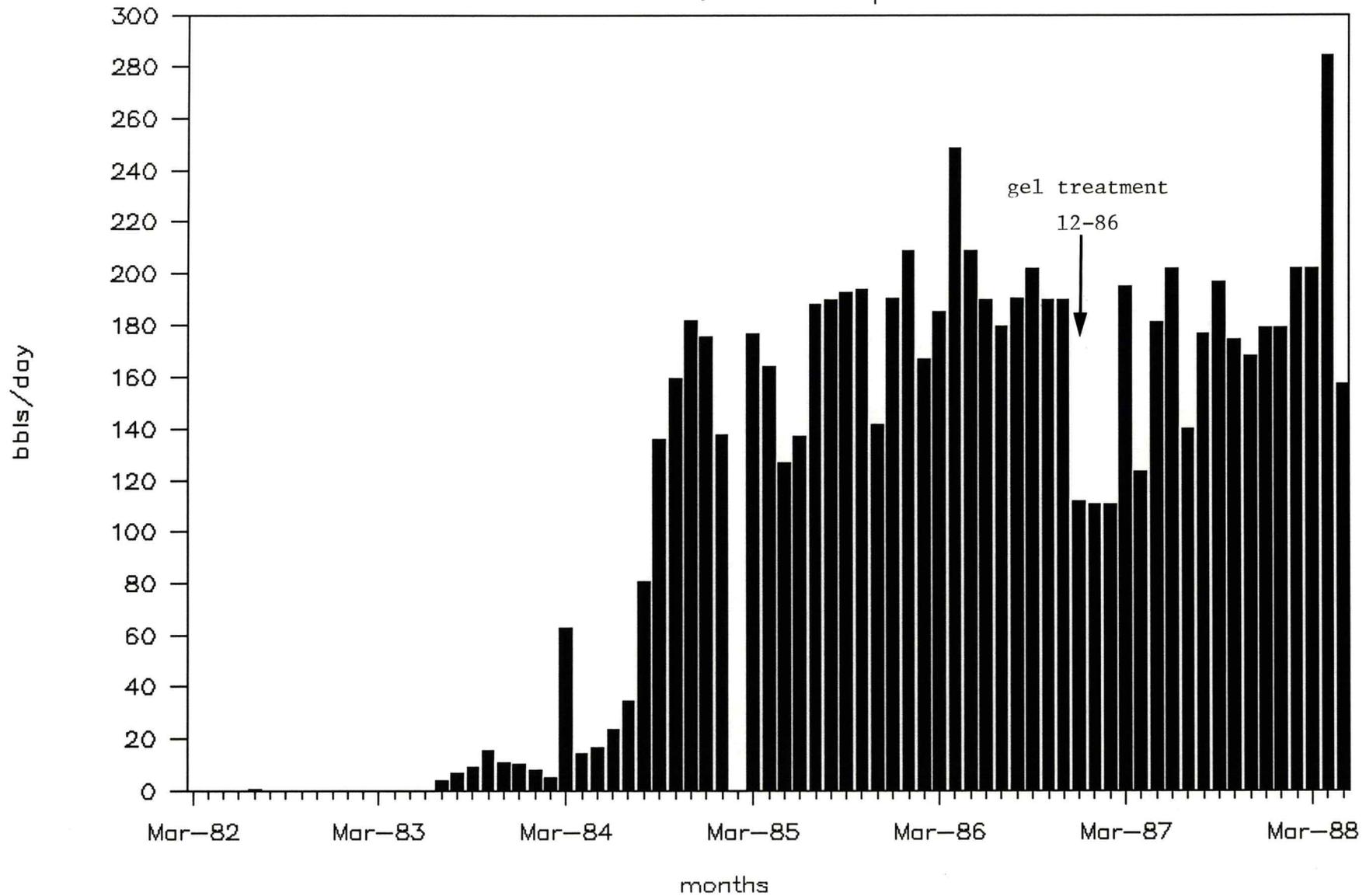


FIGURE E3

GRAPH OF INJECTIVITY INDEX VS. TIME

Nelson Lease: RW-8 B AND C

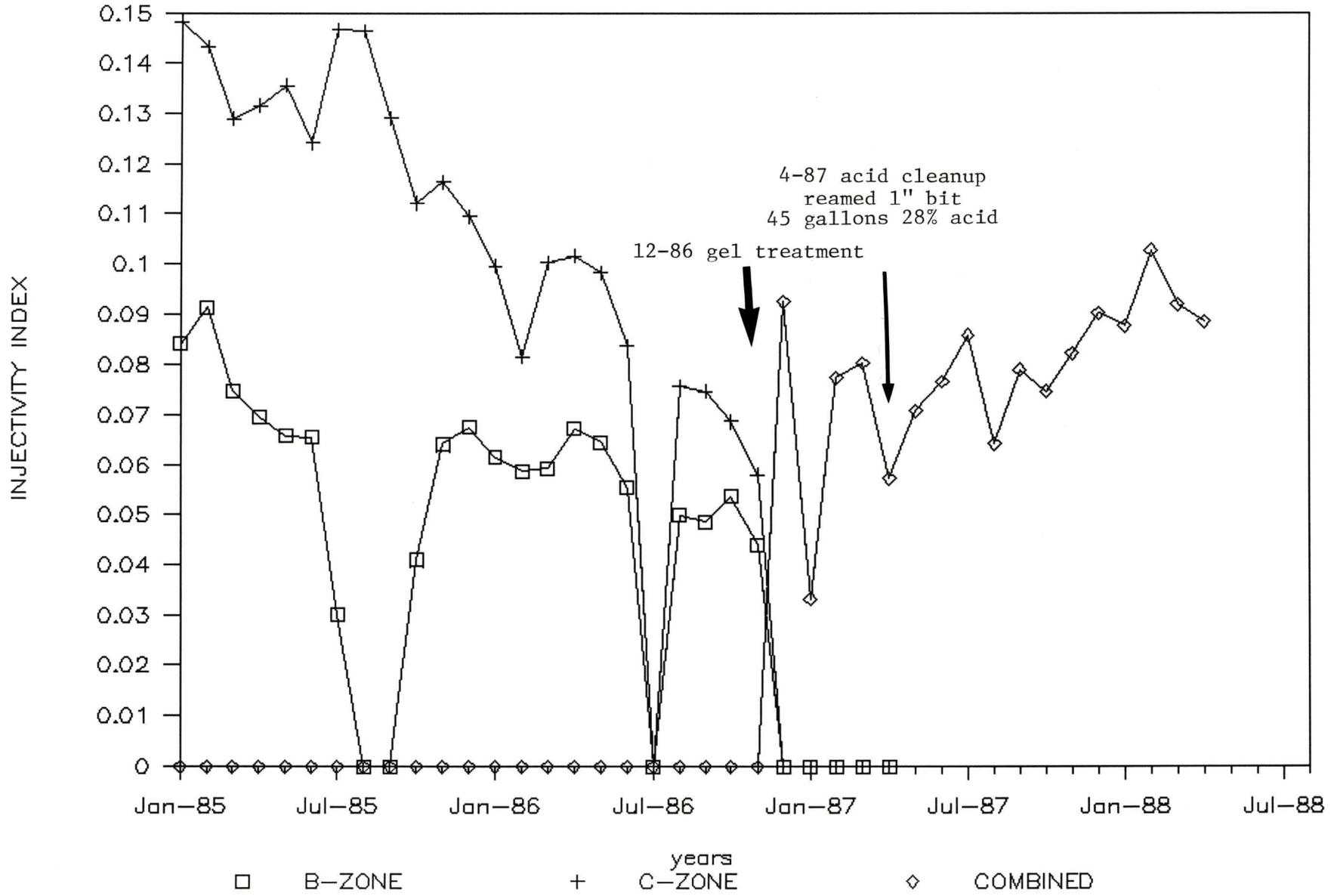


FIGURE E4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, hw-31 five spot

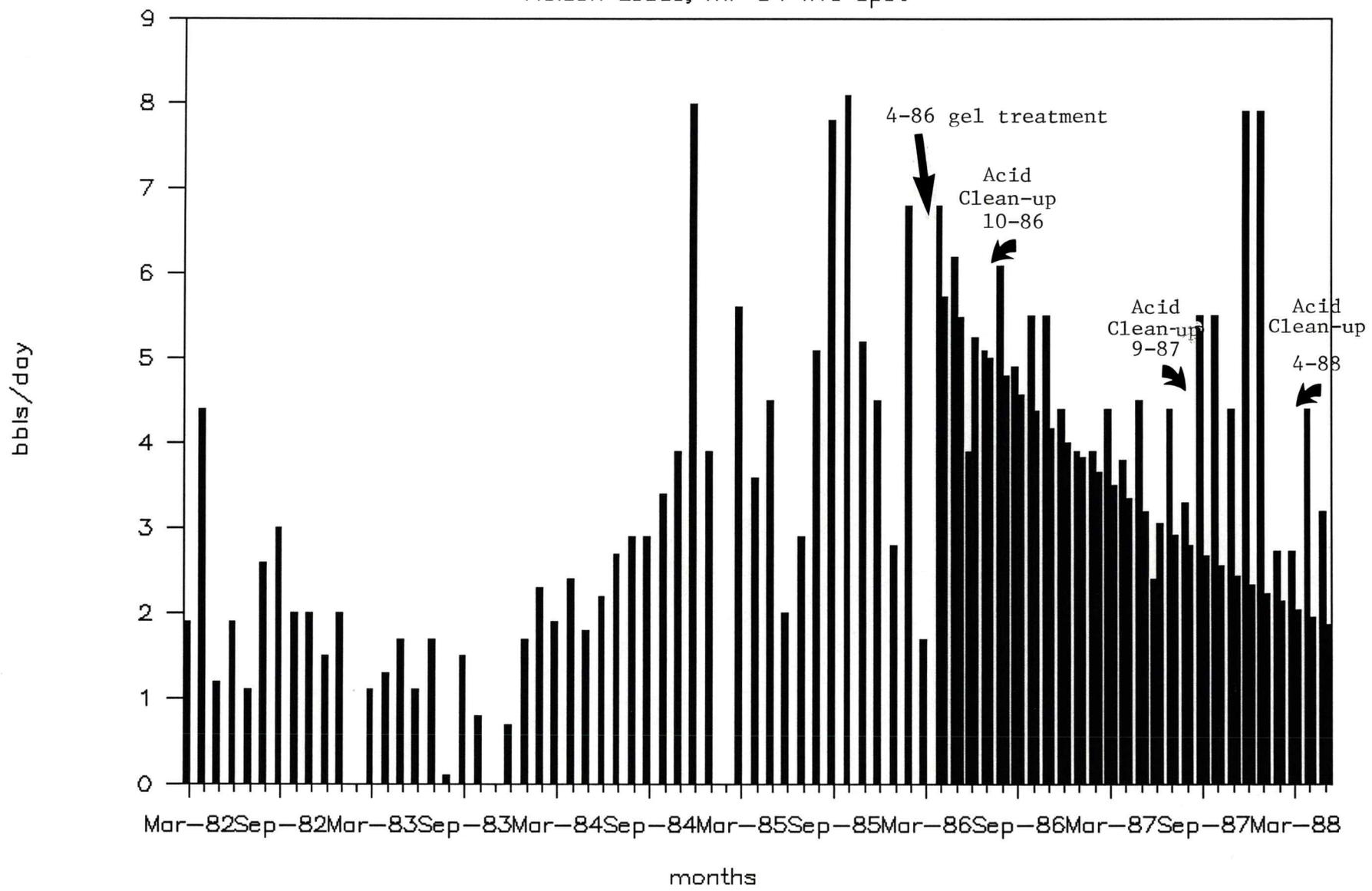


FIGURE F1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, Hw-31 five spot

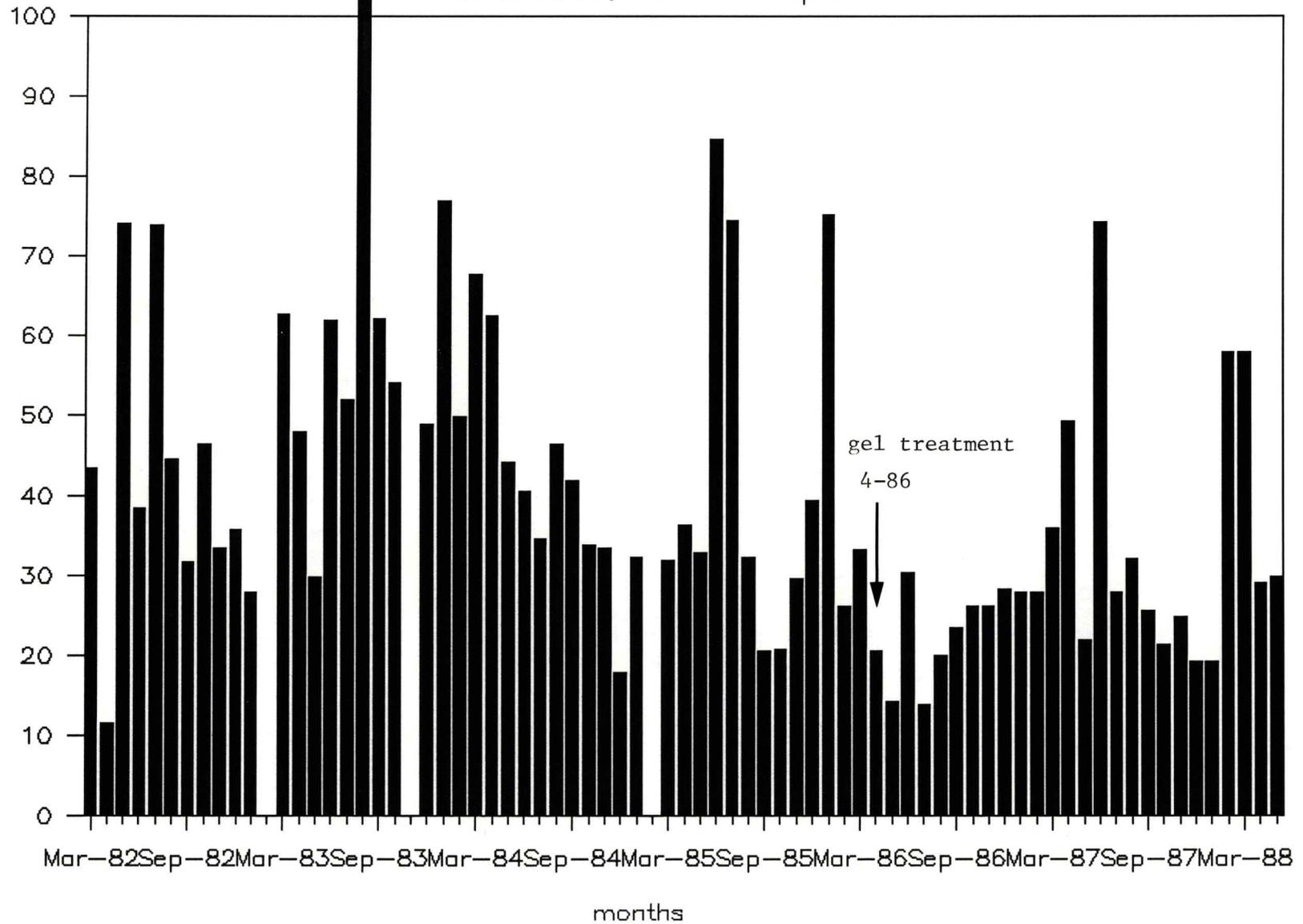


FIGURE F2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, HW-31 five spot

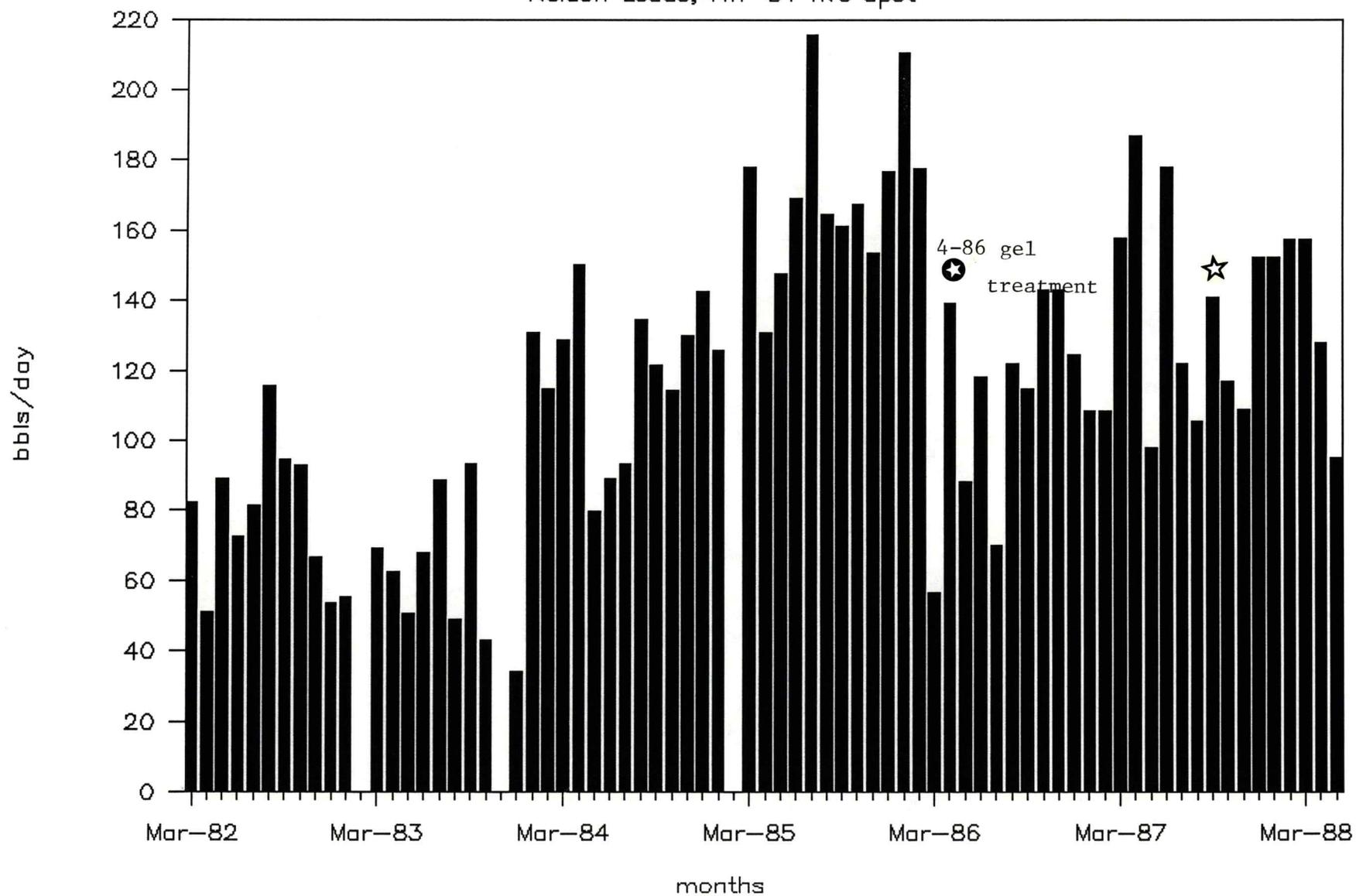


FIGURE F3

INJECTIVITY INDEX VS. TIME

HW-31

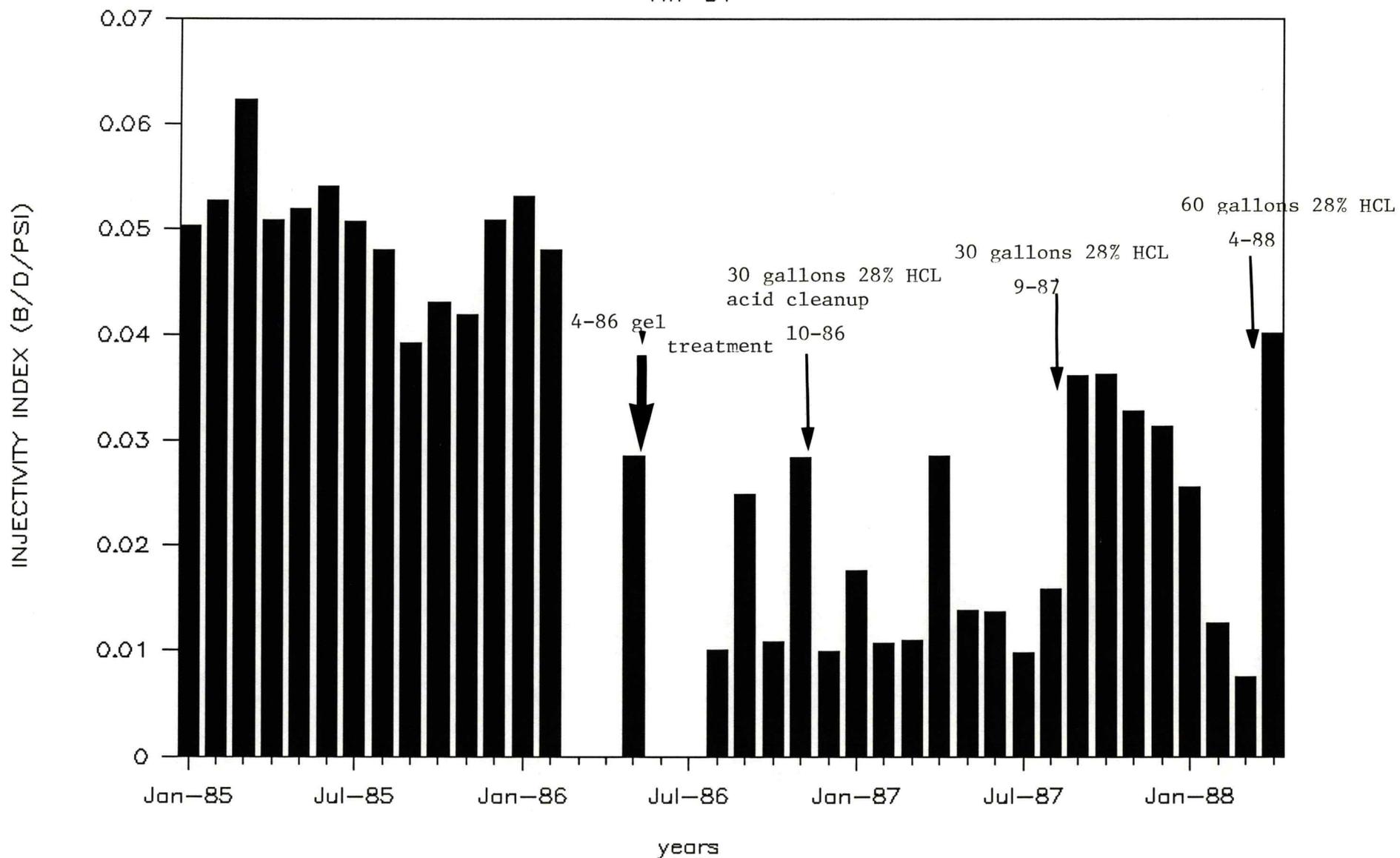


FIGURE F4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, HW-23 five spot

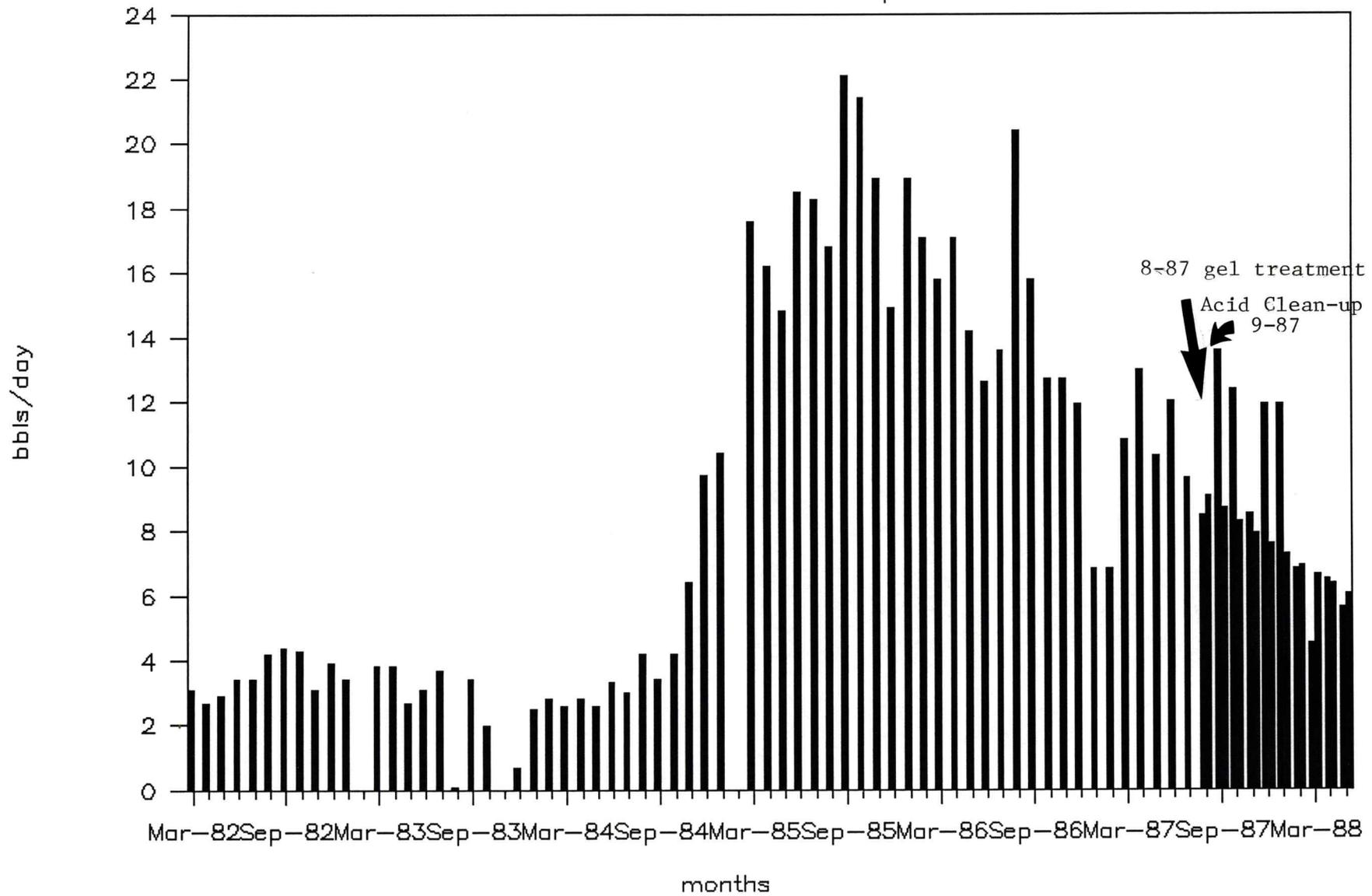


FIGURE G1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, Hw-23 five spot

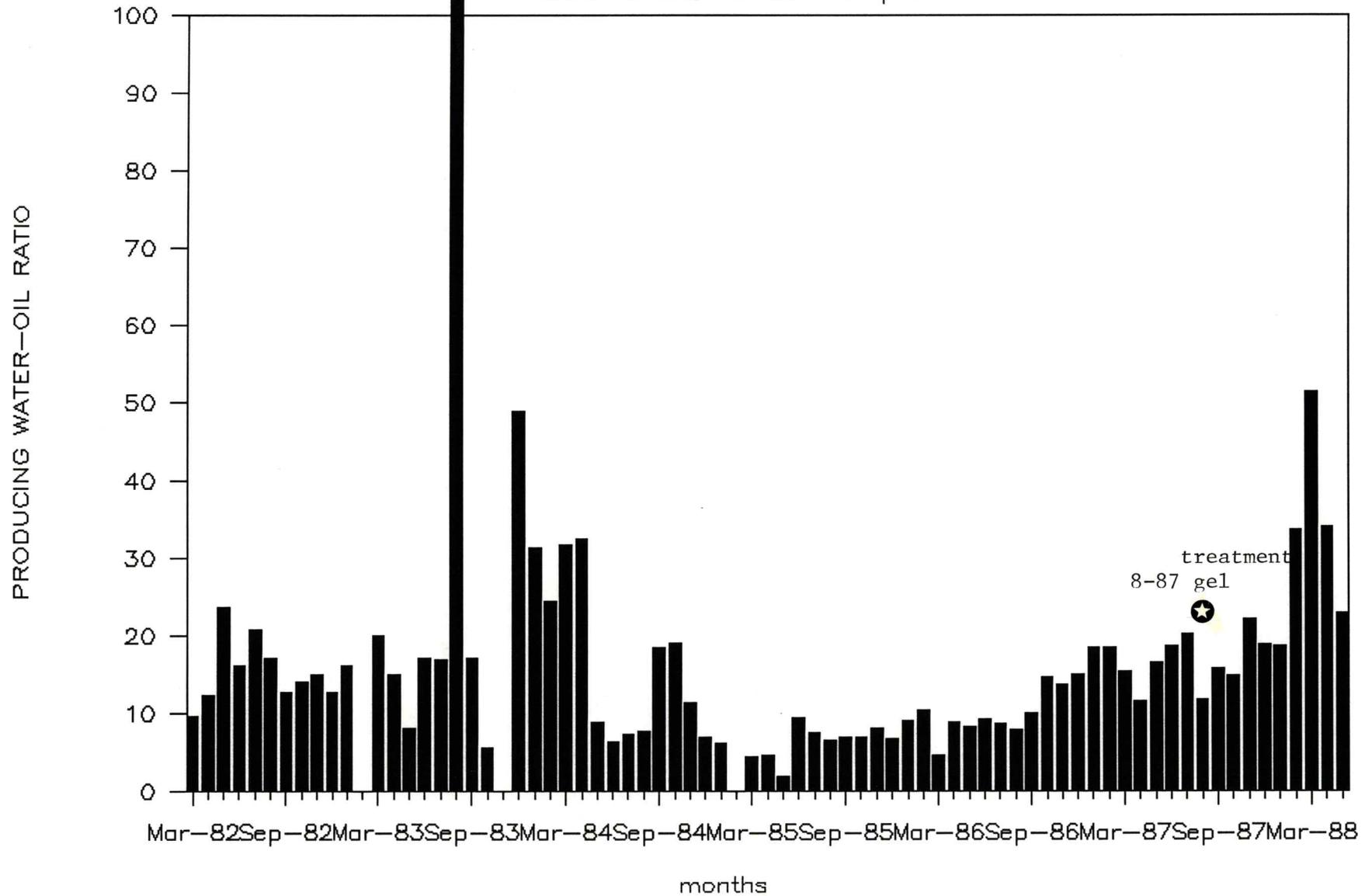


FIGURE G2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, HW-23 five spot

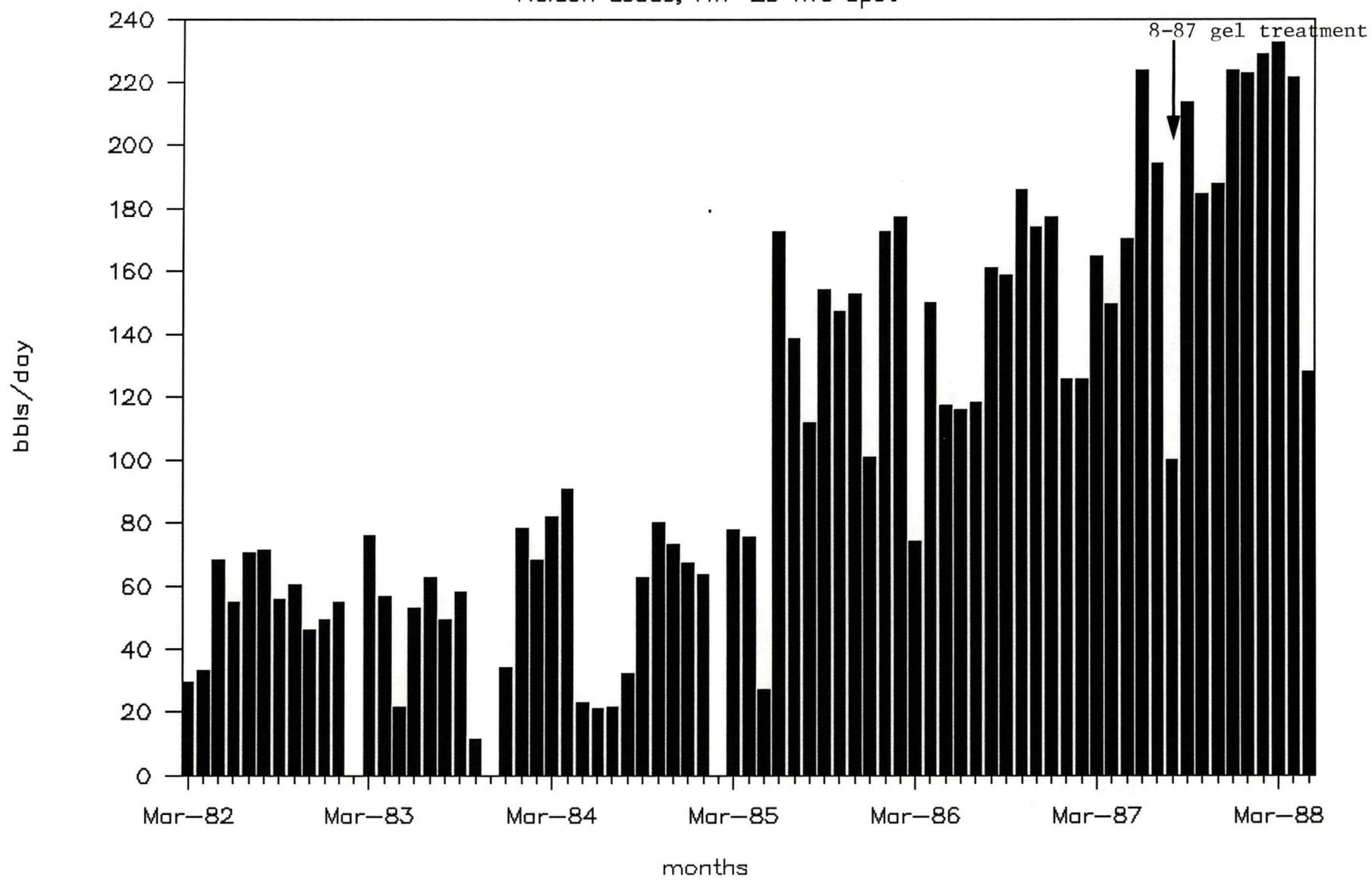


FIGURE G3

INJECTIVITY INDEX

INJECTION WELL HW-23

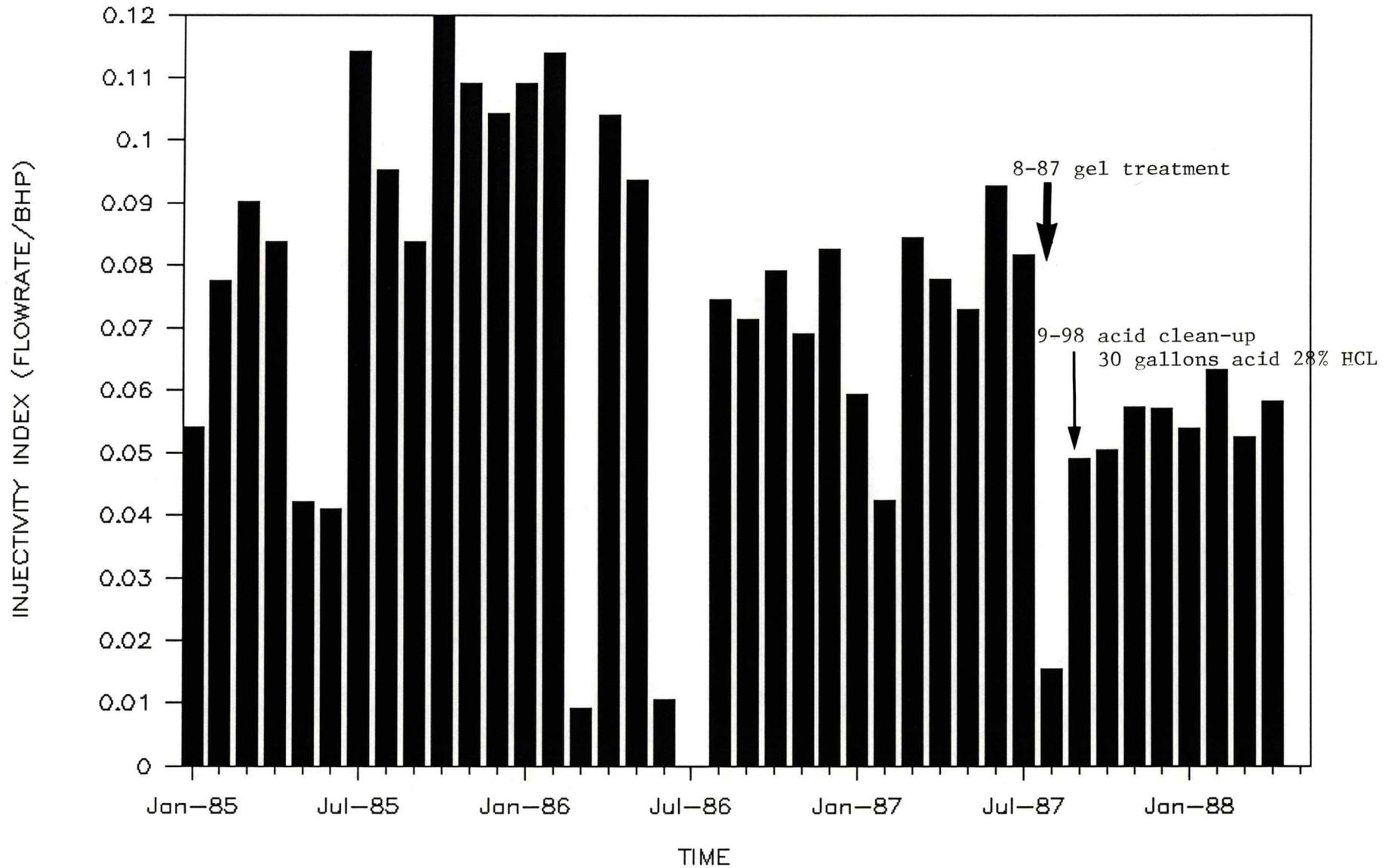


FIGURE G4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, HW-18 five spot

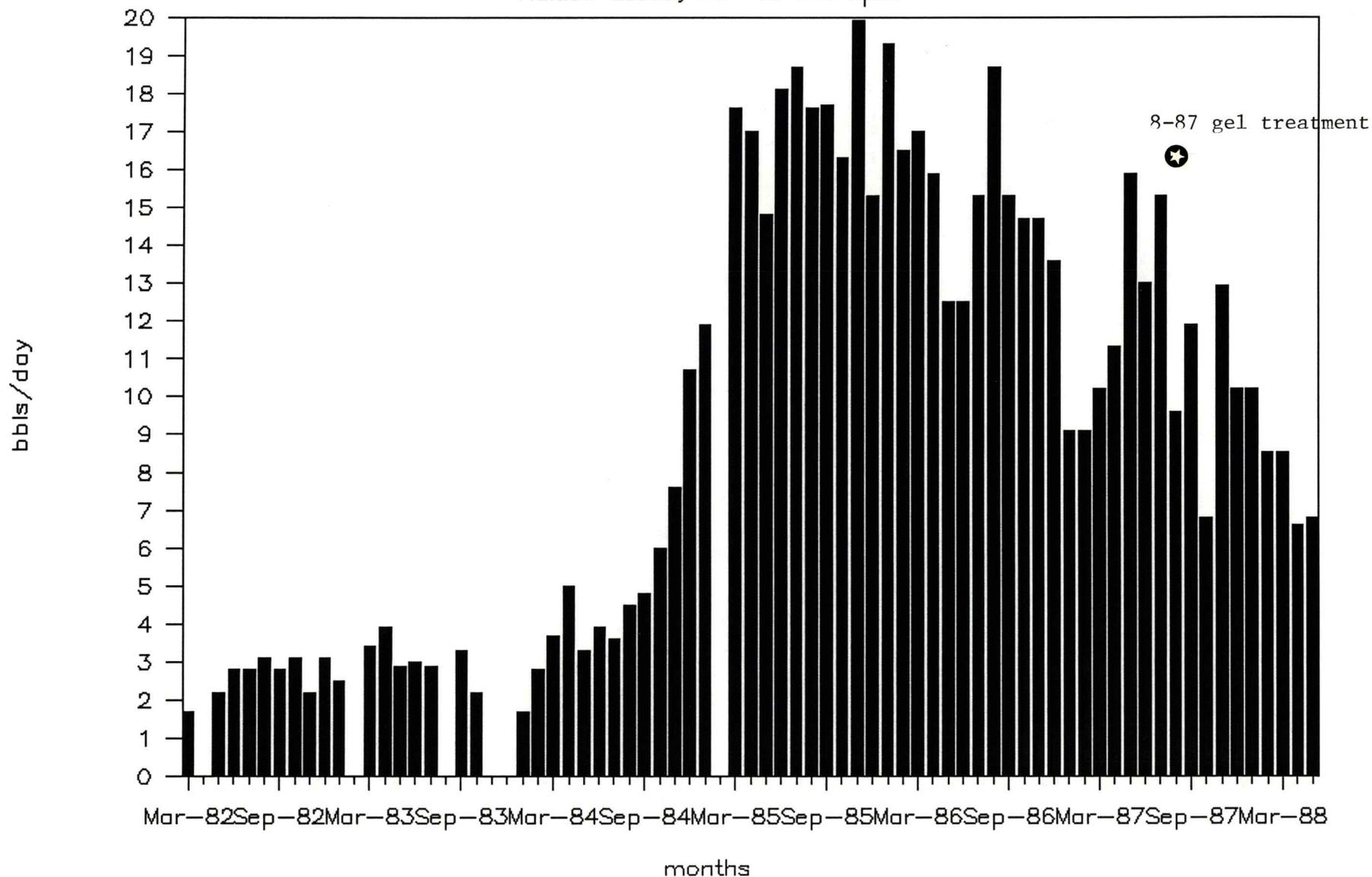
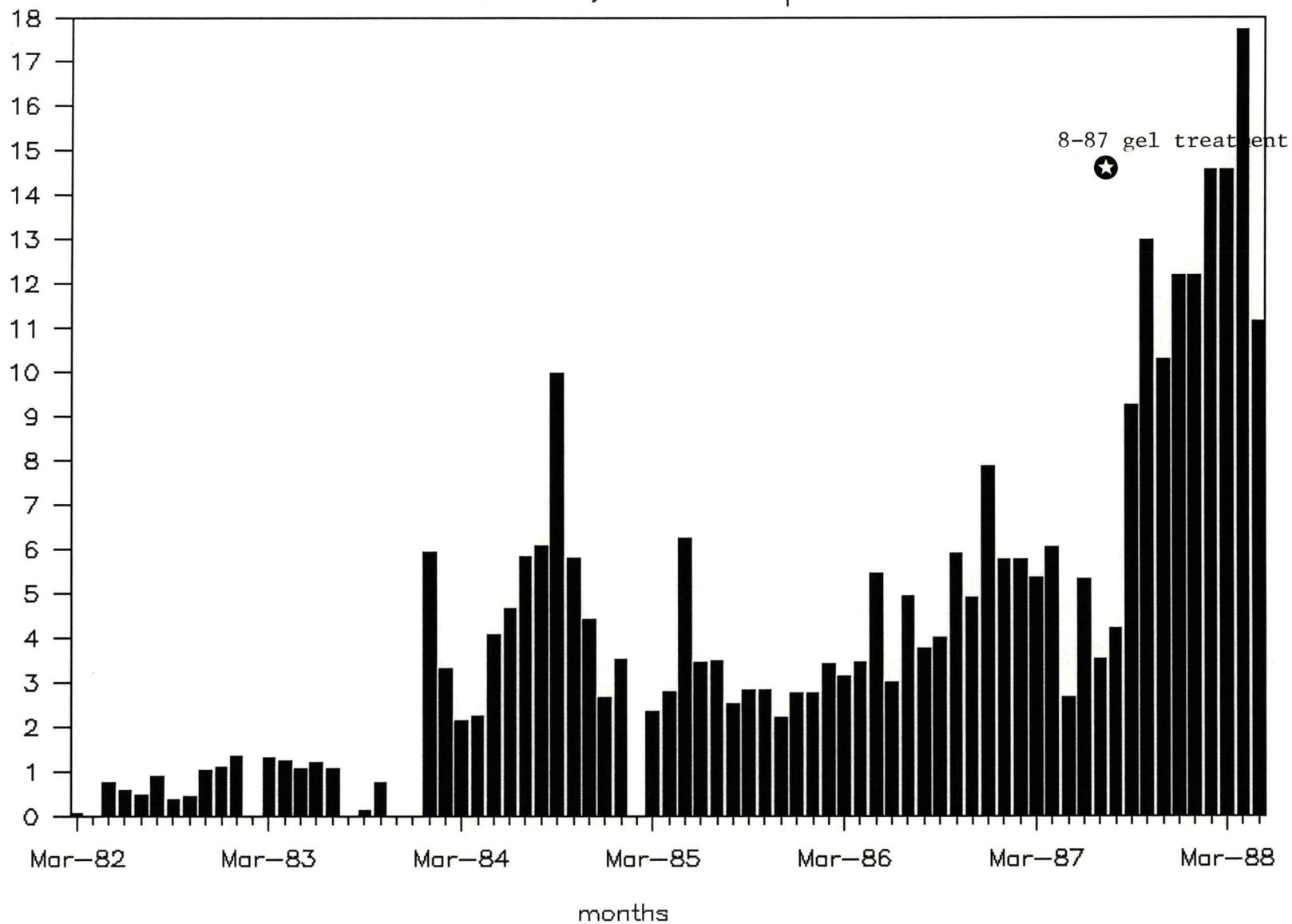


FIGURE H1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, HW-18 five spot



months
FIGURE H2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, HW-18 five spot

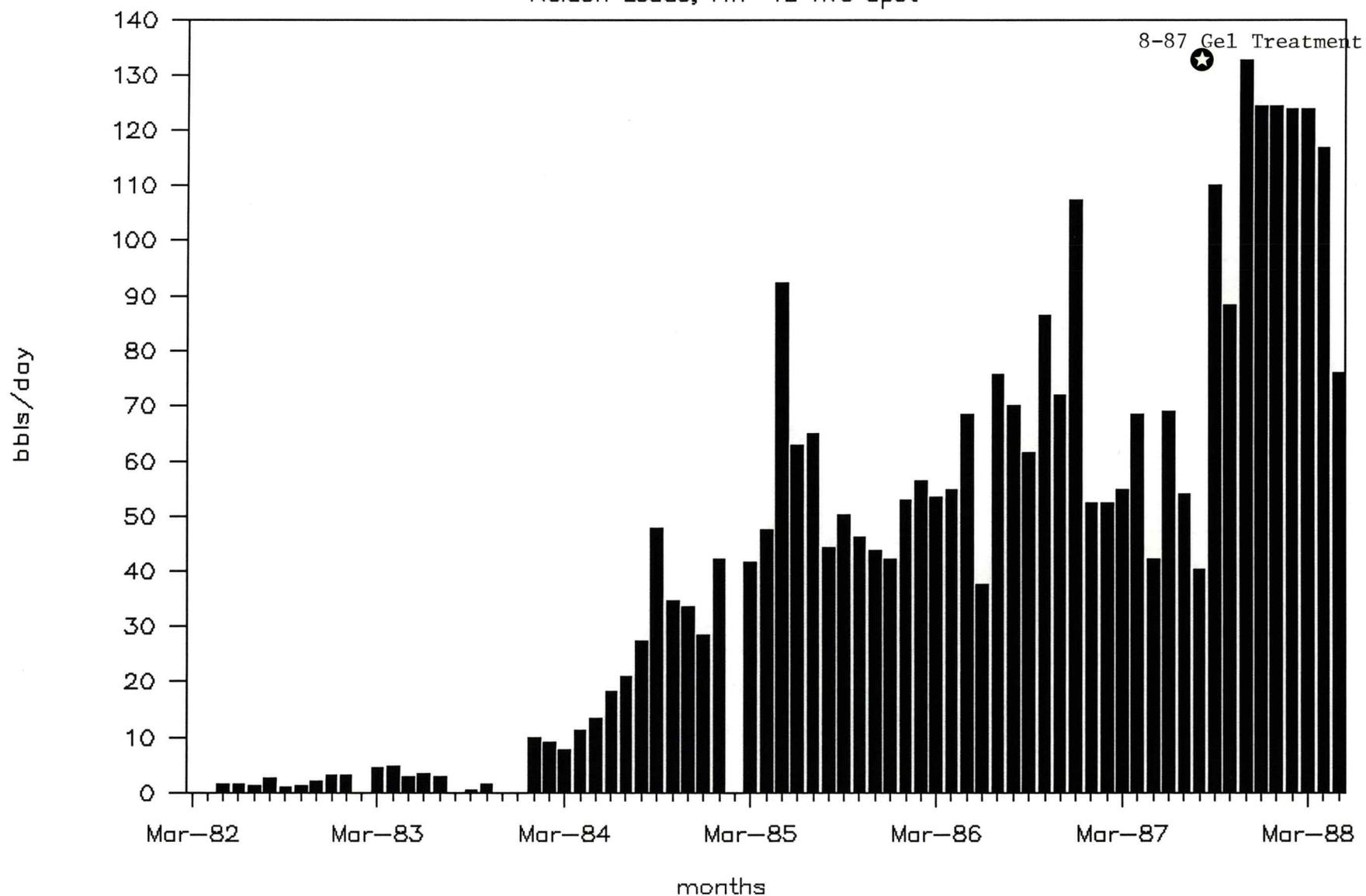
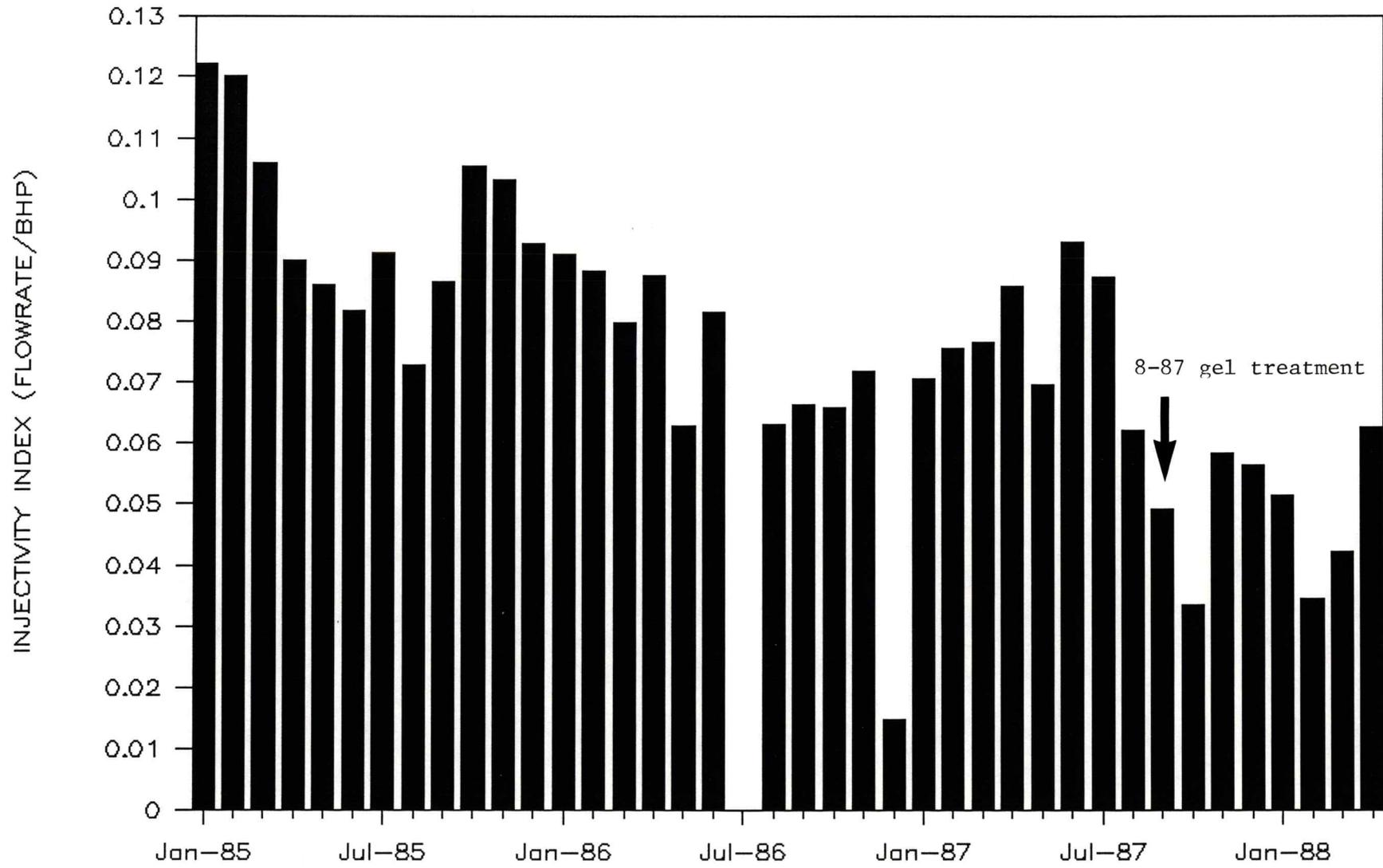


FIGURE H3

INJECTIVITY INDEX

INJECTION WELL HW-18



TIME
Figure H4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, HW-1 five spot

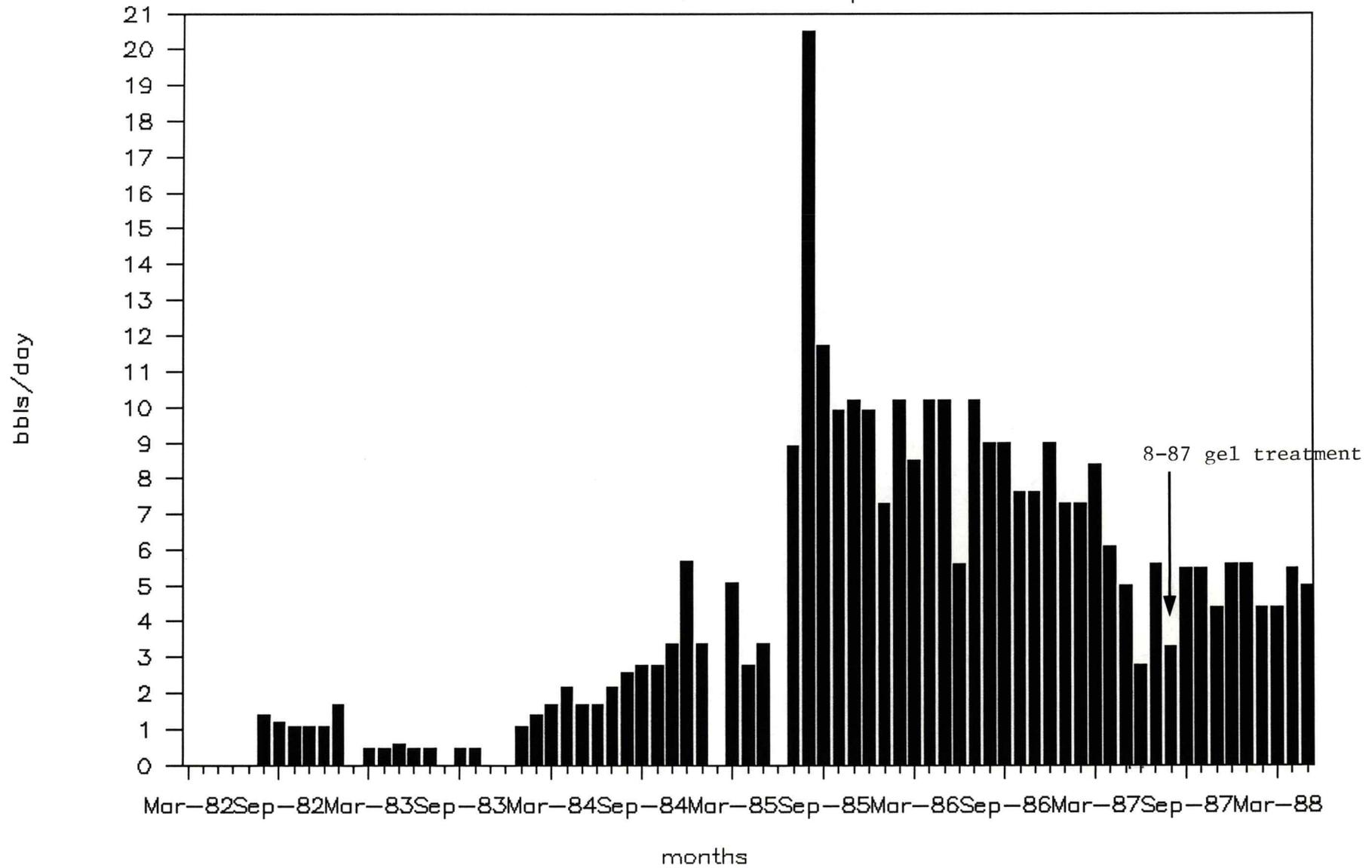
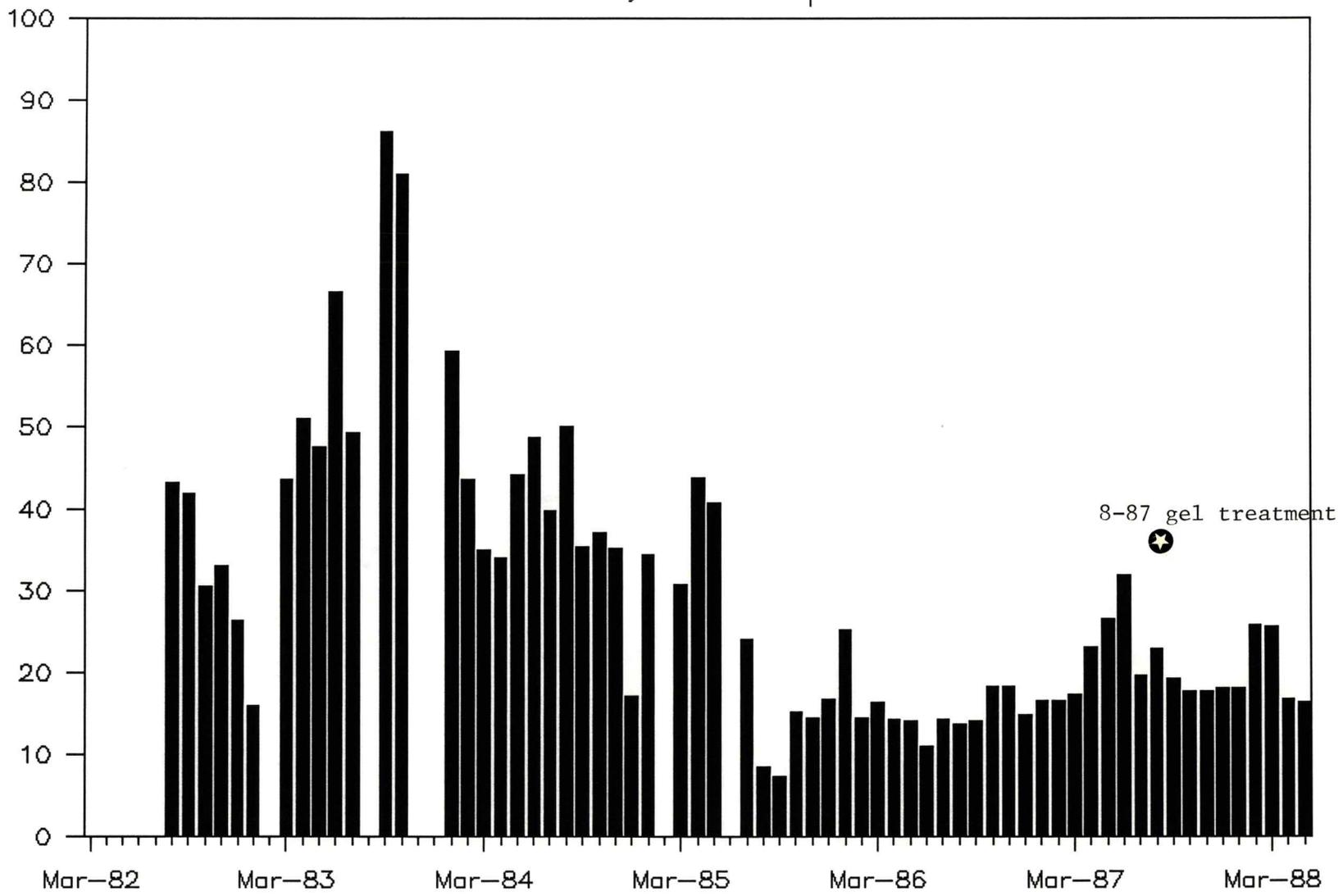


FIGURE I1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, Hw-1 five spot



months
FIGURE I2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, HW-1 five spot

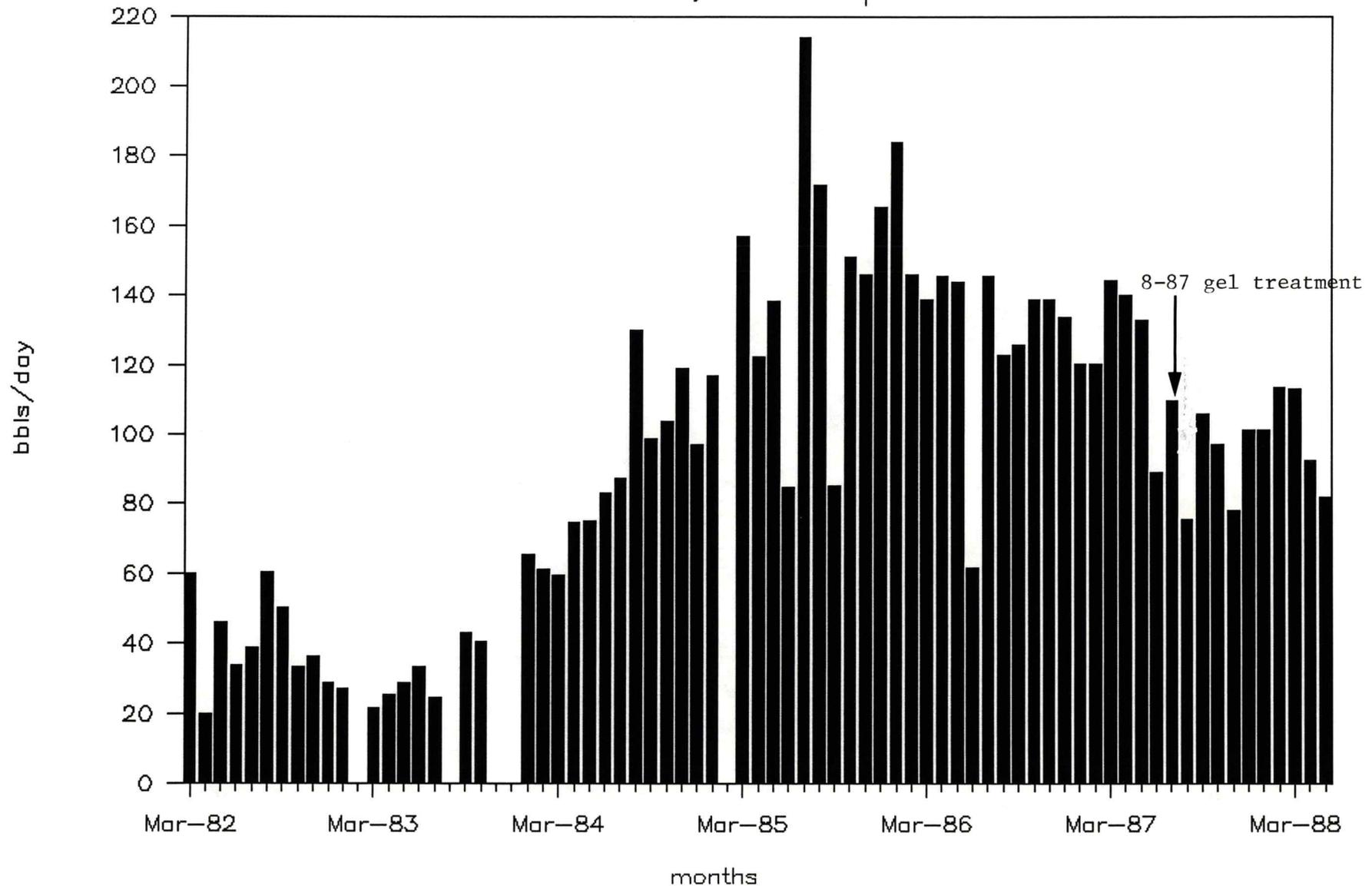
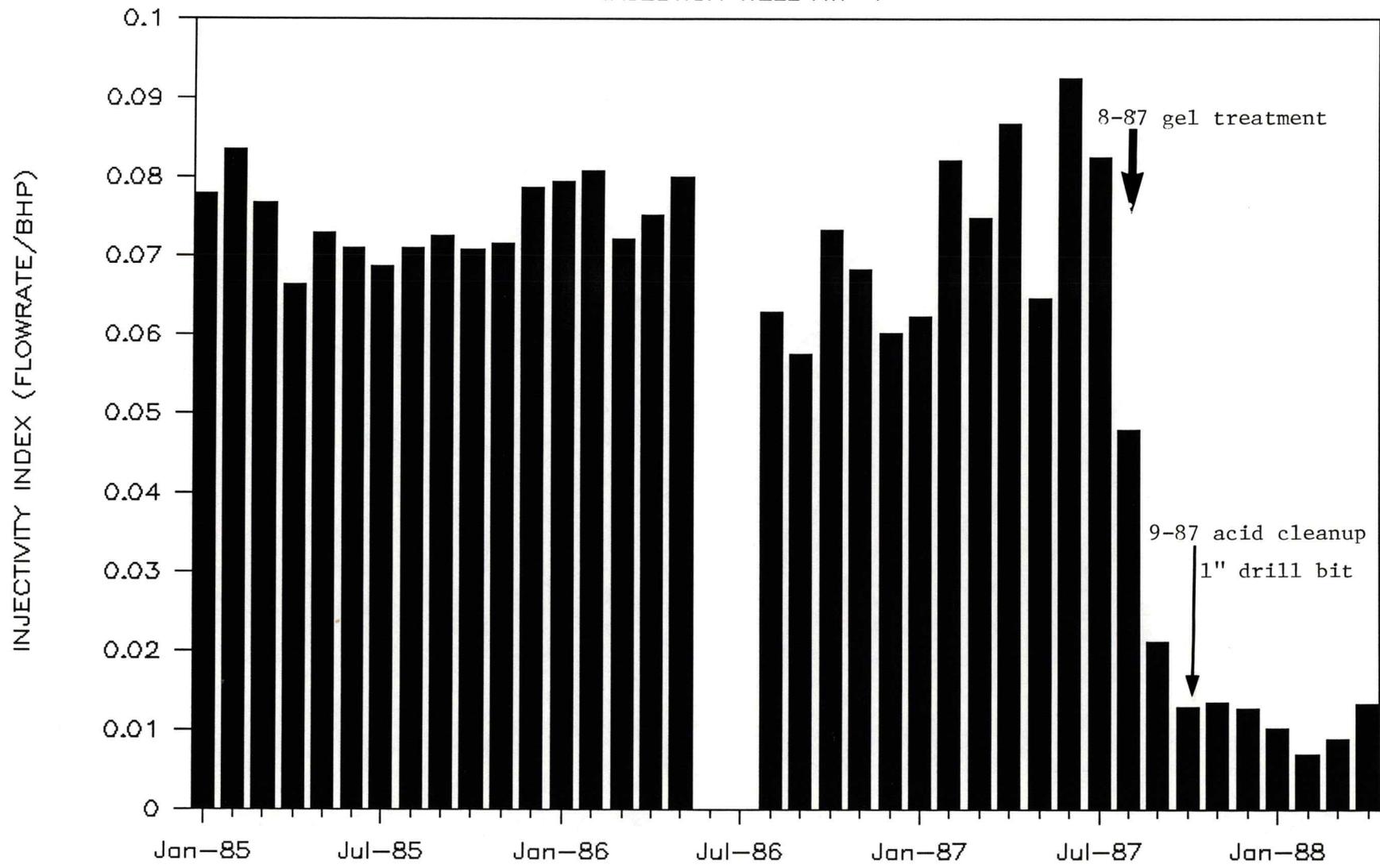


FIGURE I3

INJECTIVITY INDEX

INJECTION WELL HW-1



TIME
FIGURE I4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, HW-29 five spot

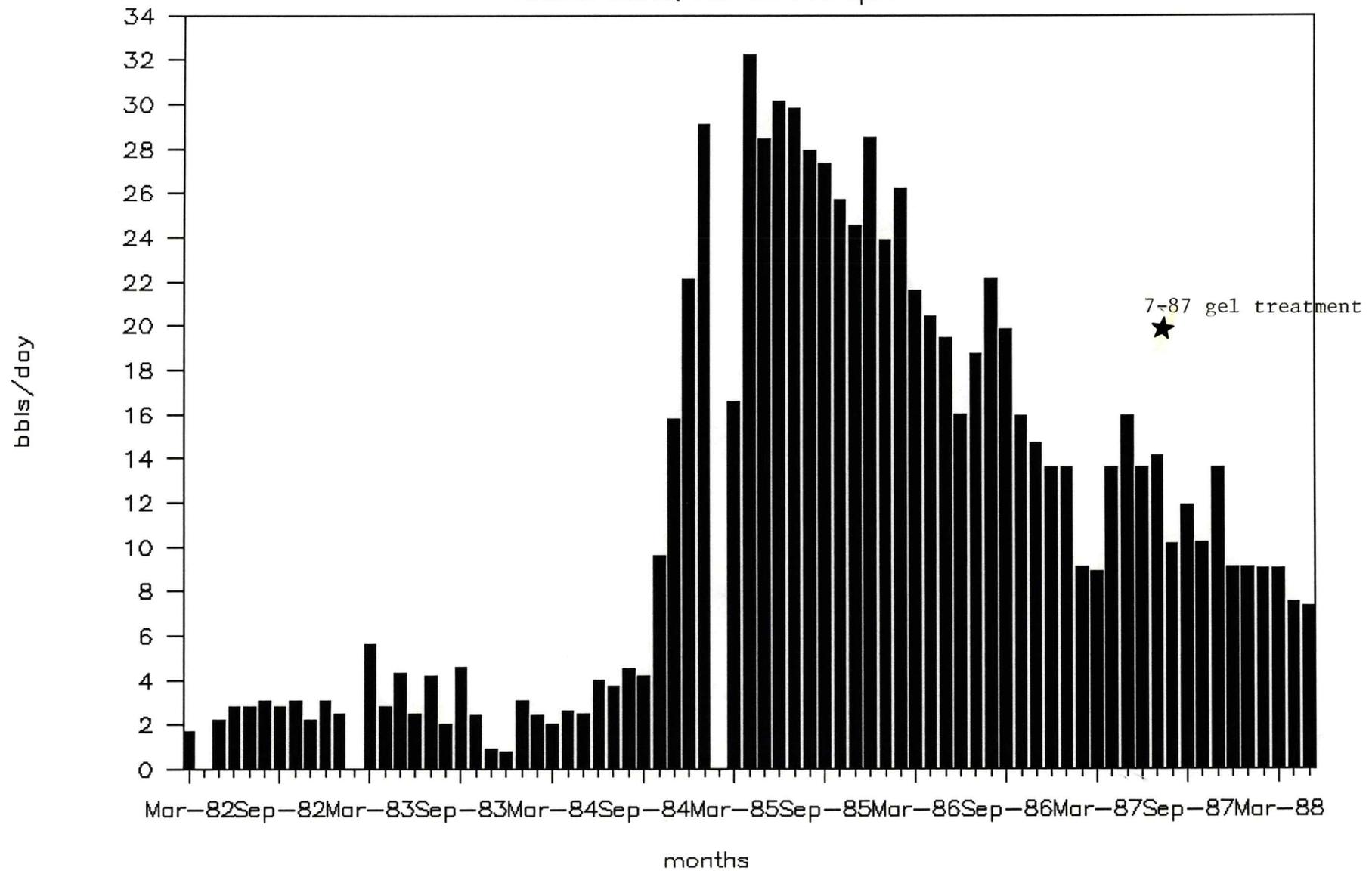


FIGURE J1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, HW-29 five spot

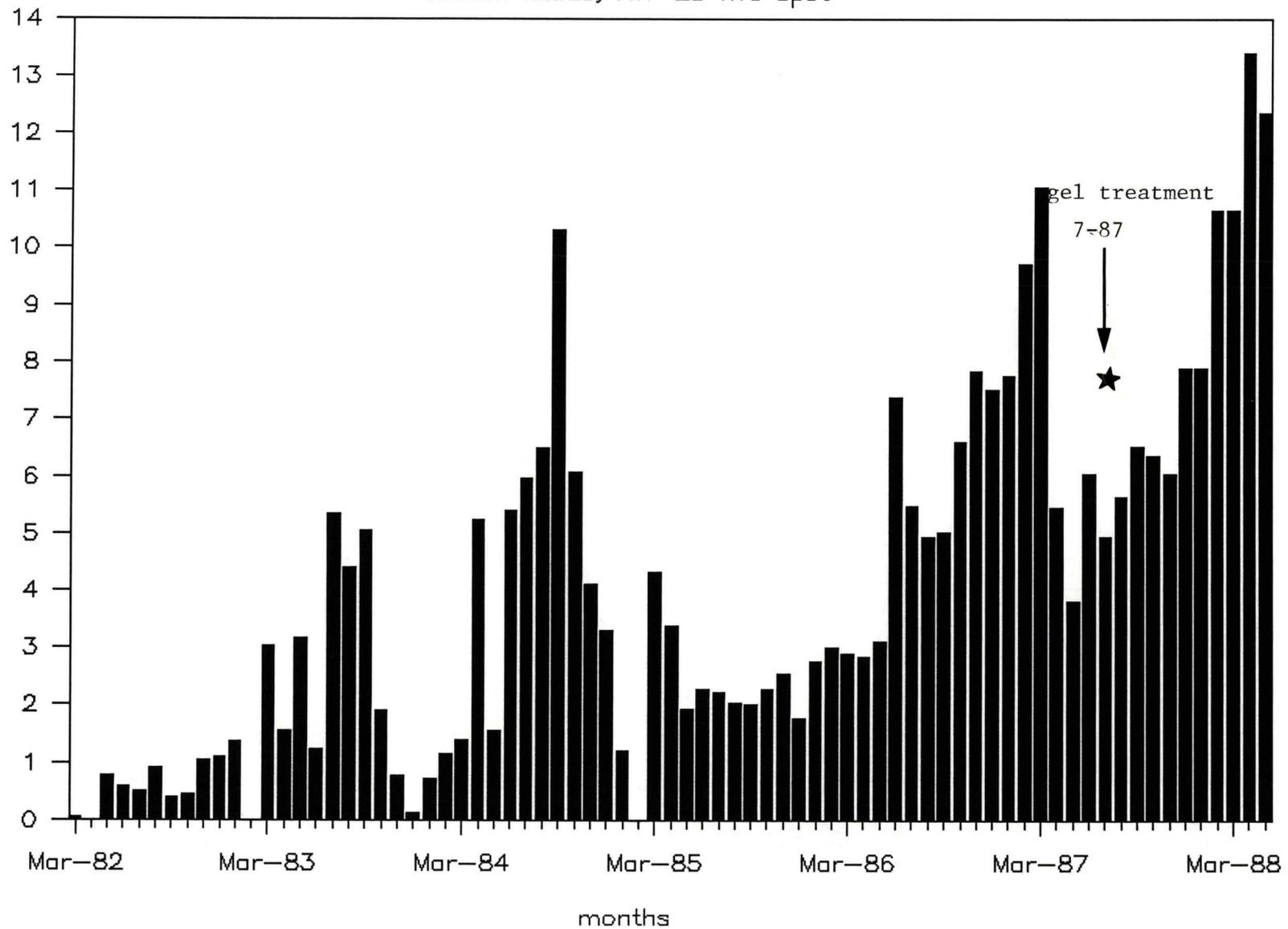


FIGURE J2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, HW-29 five spot

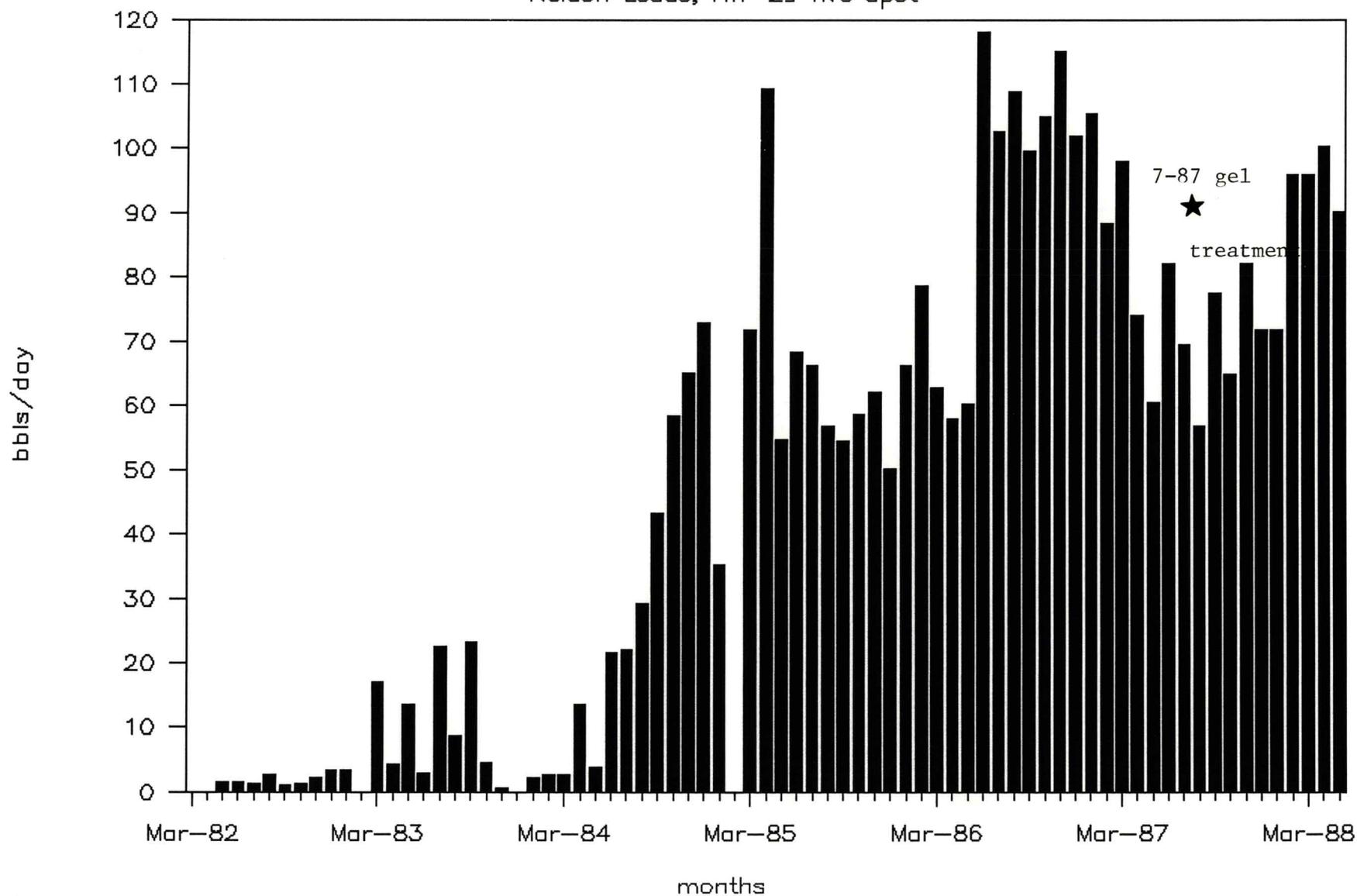


FIGURE J3

INJECTIVITY INDEX

INJECTION WELL H-29

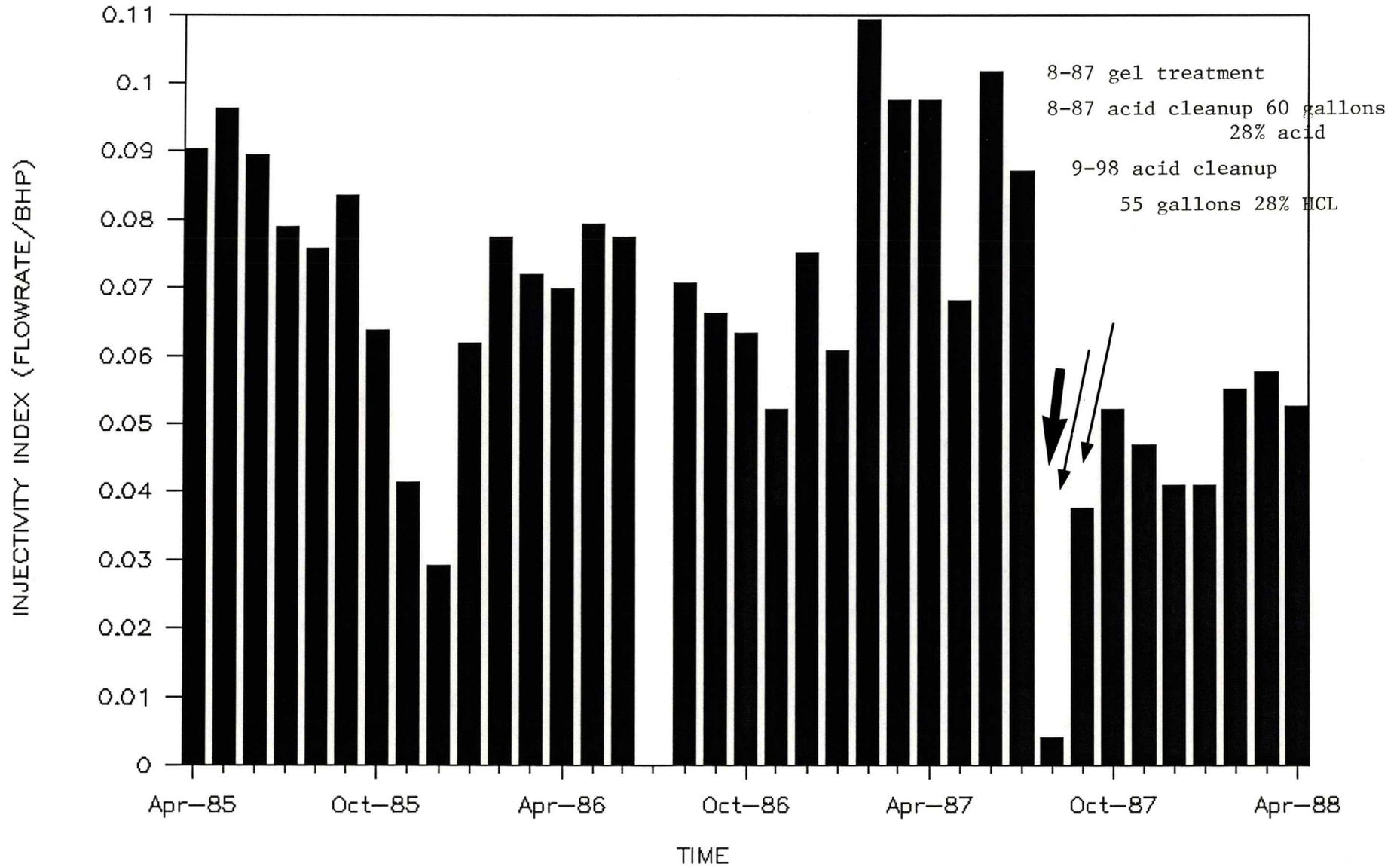


FIGURE J4

GRAPH OF OIL PRODUCTION VS. TIME

Nelson Lease, KW-6 five spot

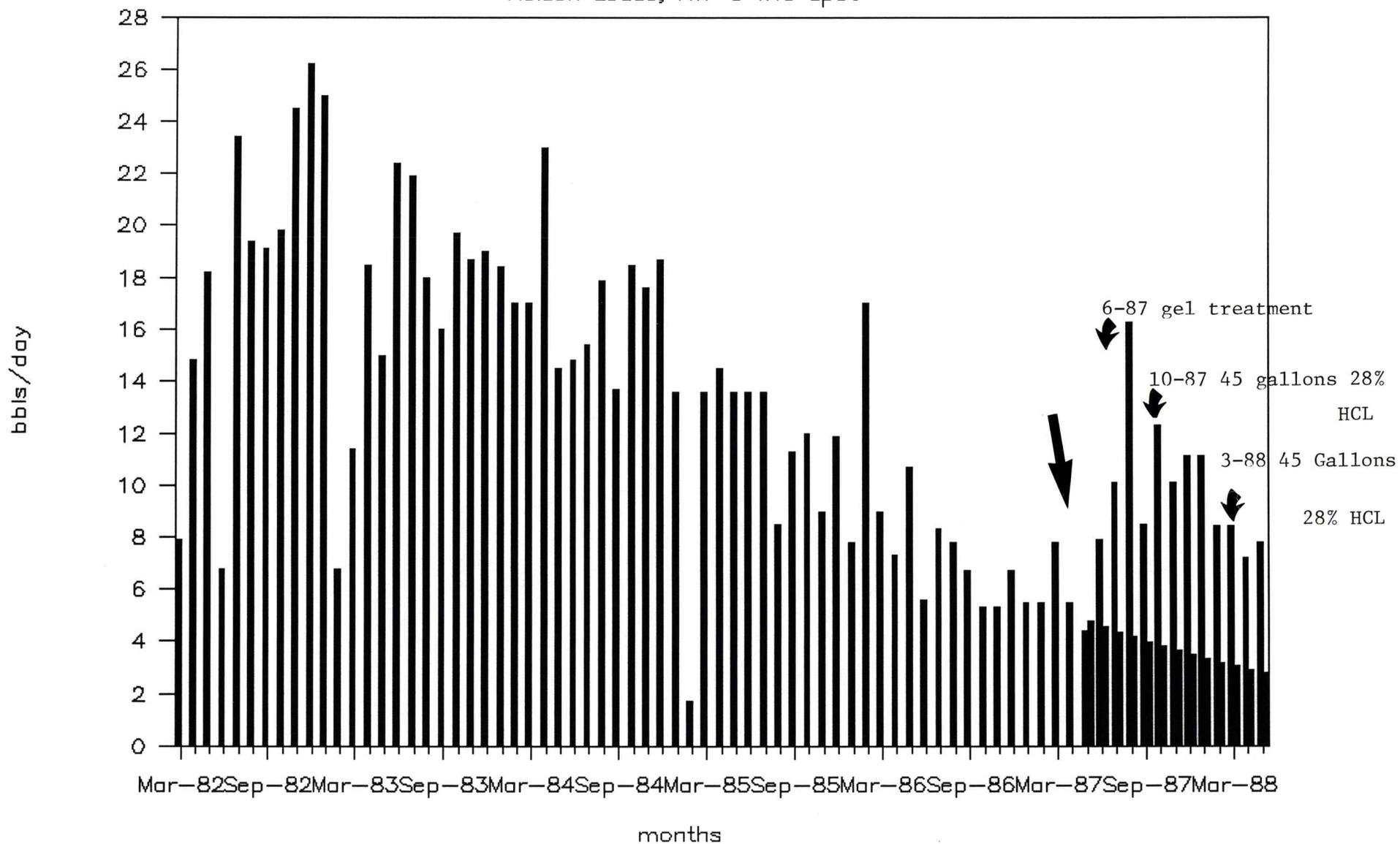


FIGURE K1

GRAPH OF WATER OIL RATIO VS. TIME

Nelson Lease, KW-6 five spot

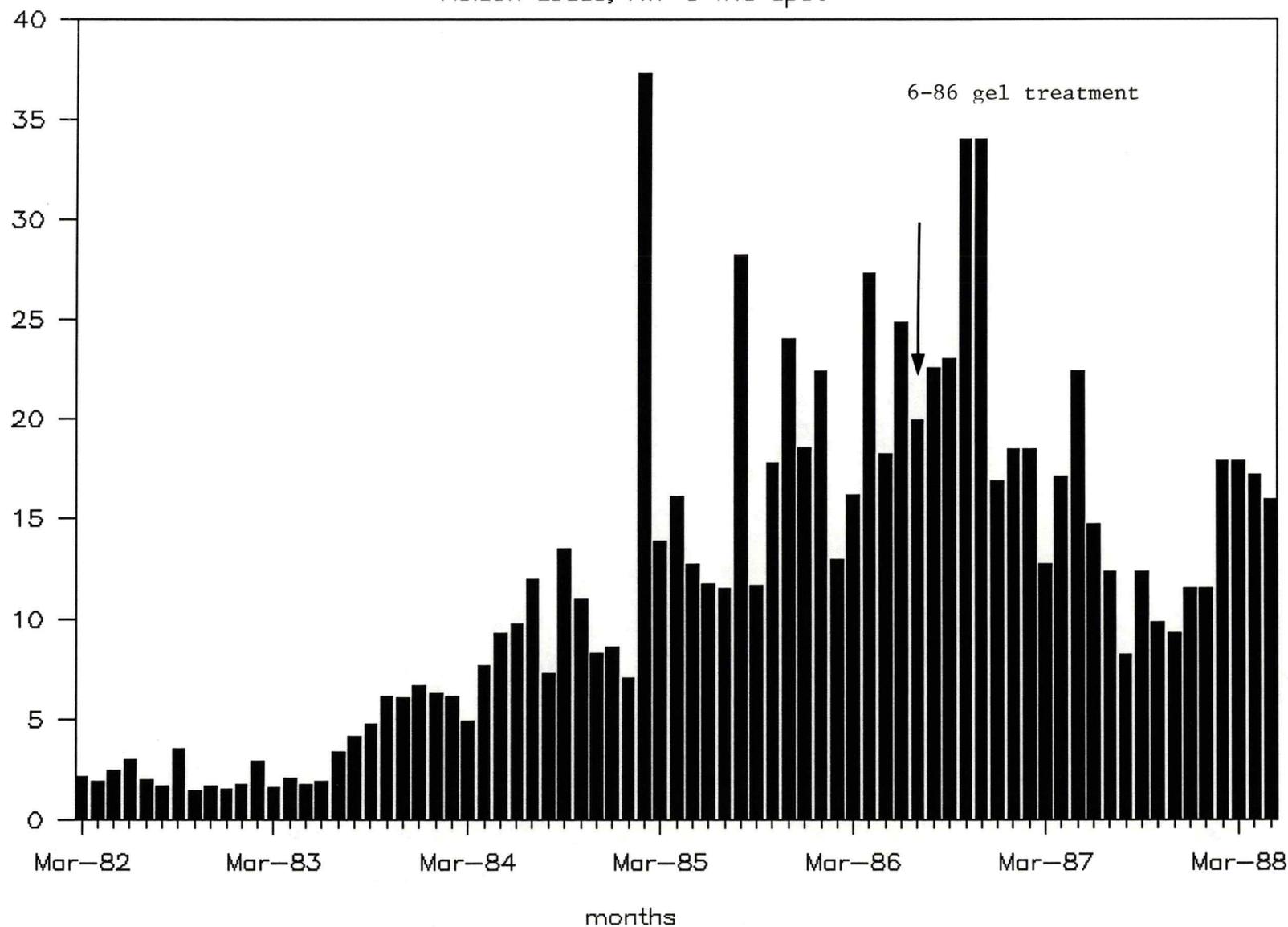


FIGURE K2

GRAPH OF WATER PRODUCTION VS. TIME

Nelson Lease, KW-6 five spot

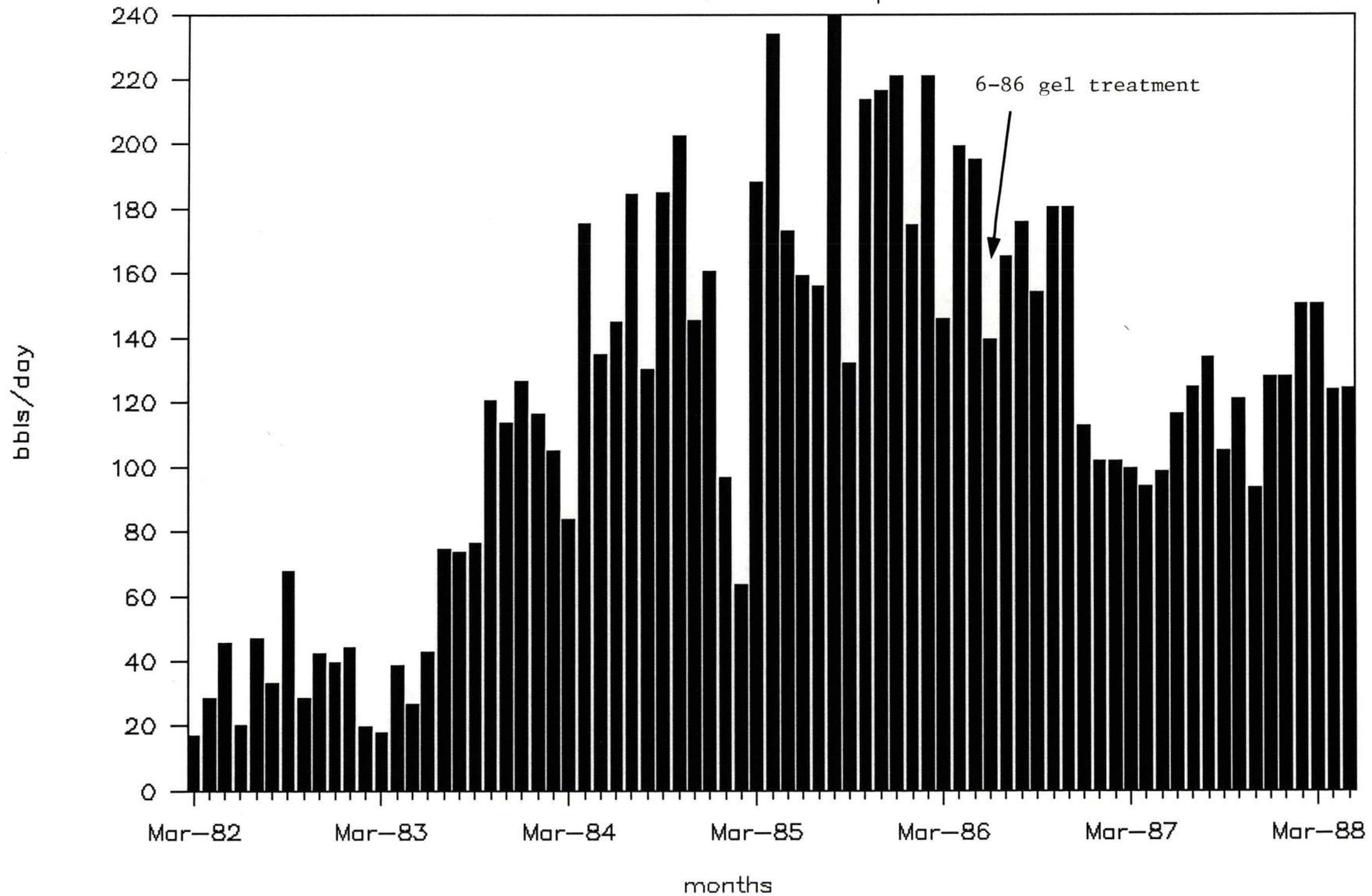


Figure K3

INJECTIVITY INDEX

KW-6

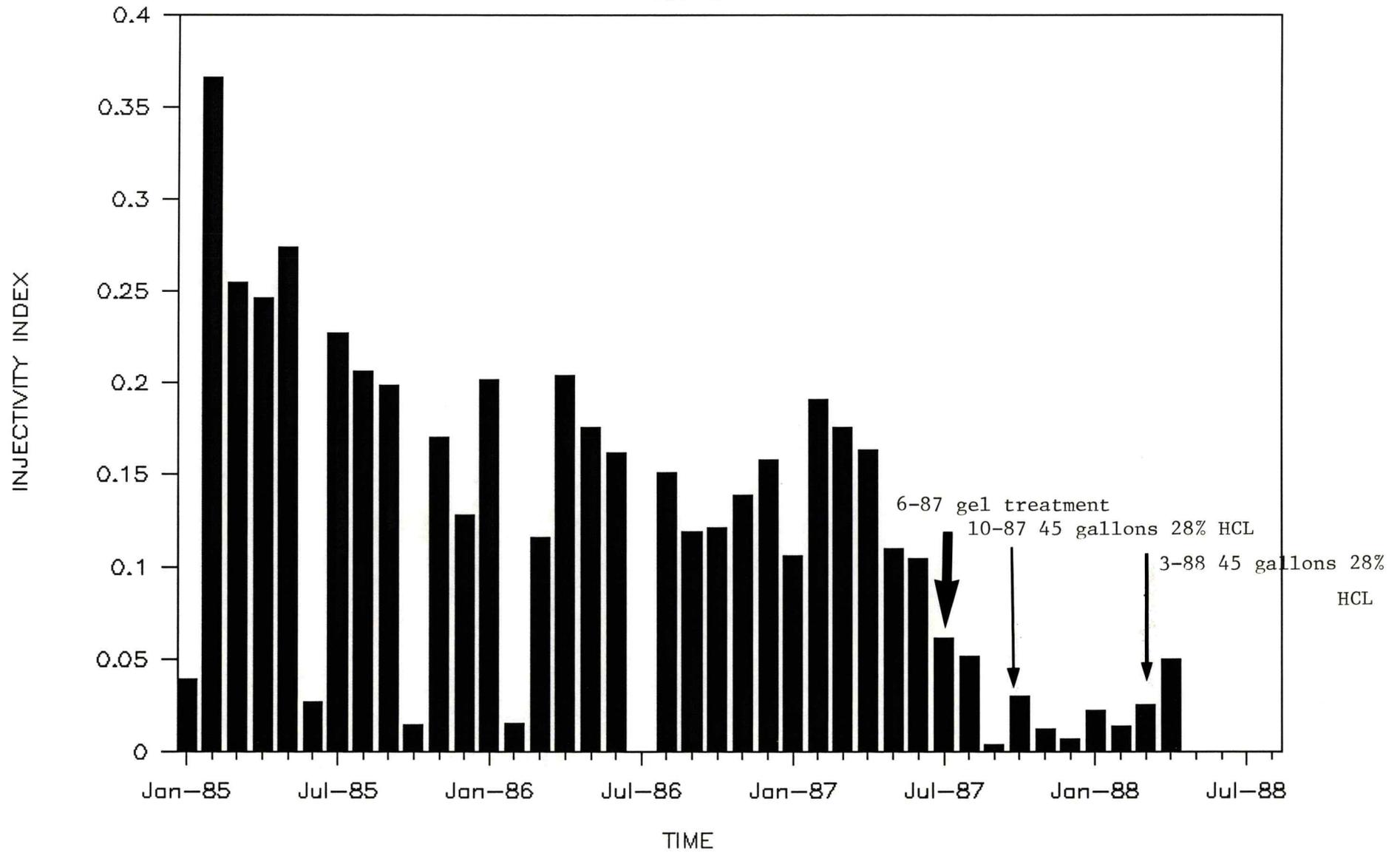


Figure K4