Appendix C1. Channel and Habitat Typing Assessment

CONTENTS

C1.1 Methods C-7
C1.2 Results C-8
C1.3 Discussion C-8
C1.3.2 Mean Percent Canopy Closure and Percent Canopy Cover C-19
C1.3.3 Percent LWD as Structural Shelter in Pool Habitats C-19
C1.3.4 Habitat Types as a Percent of Total Length C-23
C1.3.5 Pool Tail-out Embededness as Percent Occurrence C-24
C1.3.6 Maximum Residual Pool Depth as Percent Occurrence C-27
C1.4 Conclusions C-27
C1.5 References C-29

Figures

Figure C1-1. Canopy closure versus watershed area for all streams within the Plan Area in which habitat typing surveys were conducted. C-20
Figure C1-2. Percent conifer canopy versus watershed area for all streams within the Plan Area in which habitat typing surveys were conducted. C-21
Figure C1-3. Percentage of LWD as structural shelter versus watershed area for Plan Area streams surveyed during habitat assessments. C-22
Figure C1-4. Percent of stream length in pools plotted by watershed area for all streams assessed during the habitat assessments. C-25
Figure C1-5. Index of streambed embeddedness as a function of stream gradient for all streams within the Plan Area which were assessed. ... C-26
Figure C1-6. Mean maximum pool depths plotted against water acres for Plan Area streams. C-28

Tables

Table C1-1. Summary of the channel and habitat typing assessments conducted during 1991-1998 on stream within the Plan Area. C-8

Table C1-2. Stream assessment summaries for the Smith River HPA. C-9

Table C1-3. Stream assessment summaries for the Coastal Klamath HPA. C-10

Table C1-4. Stream assessment summaries for the Blue Creek HPA. C-13

Table C1-5. Stream assessment summaries for the Interior Klamath HPA. C-14

Table C1-6. Stream assessment summaries for the Little River HPA. C-16

Table C1-7. Stream assessment summaries for the Mad River HPA and North Fork Mad River HPA. C-17

Table C1-8. Stream assessment summaries for the Humboldt Bay HPA and Eel River HPA. C-18

C1.1 METHODS

Initial channel and habitat typing assessments were conducted by Green Diamond Fisheries personnel in 1994 and 1995 following the CDFG methods described by Flosi and Reynolds (1994). Prior to the onset of assessments, Green Diamond's fisheries field technicians participated in a four-day training seminar sponsored by CDFG in order to become familiar with the methodology. In the 1995 season, Green Diamond field personnel followed the 10% sampling scheme modification proposed by CDFG to reduce the time required for this assessment (Hopelain 1995). All field data was entered into the Habitat Program (Flosi and Reynolds 1994) and resulting data tabulated, summarized, and discussed below.

During those two years Green Diamond fisheries personnel assessed sixteen streams on Green Diamond's ownership in the HPAs, identifying 75 reaches by channel type for a total of over 94 miles of stream channel examined (Table C1-1). The sixteen streams assessed were selected based on their biological significance as producers of salmonids, and the size of Green Diamond's ownership in the watershed's anadromous reaches.

Additionally, channel and habitat typing assessments of streams on Green Diamond's ownership in the HPAs also were conducted by the Yurok Tribal Fisheries Program (YTFP) (31 streams during VN1996-1998), the California Conservation Corp (CCC) (3 streams in 1995), the Louisiana Pacific Corp. (4 streams in 1994), and the California Department of Fish and Game (CDFG) (4 streams in 1991 and 1998). Assessments by those entities were conducted on 42 streams covering more than 149 reaches for a total of over 135 miles of channel (Table C1-1).

For the purposes of summarizing and comparing stream channel and habitat parameters several of the channel and habitat typing variables (canopy closure, % conifer canopy, % LWD as structural shelter, and % of stream length in pool) were plotted against stream watershed area. These variables were mean values for the entire length of stream that was surveyed. For comparison purposes to other surveyed streams within each HPA the watershed area was determined at the midpoint of the surveyed reach of stream. The dry sections of channel in the lower portion of the watershed were not included in the overall stream length. The mid point of the wetted channel length normalizes the stream size based on the relative position in the watershed where the survey occurred and the mean values of interest. The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. These data were not transformed to find the best fit but just to get a general sense of how conditions in certain HPAs compare with those other HPAs. The R^2 and p-values are also shown on the figures.

To allow the comparison of pool tail-out embeddedness between assessed streams, a stream gradient was determined from the channel types. Each channel type has a delineation criteria based on a range of channel gradients. To derive an average stream gradient, the mean gradient of each channel type criteria was weighted according to the length of each channel type.

Table C1-1. Summary of the channel and habitat typing assessments conducted during 1991-1998 on Green Diamond's ownership in the HPAs.

HPA	Surveyed By:										Totals	
	Green Diamond		Yurok Tribal Fisheries Program		Louisiana-Pacific		CCC[1]		CDFG[2]			
	No. streams	Miles	No. streams	Miles	No. streams	Miles	No. streams	Miles	No. streams	Miles	No. streams	Miles
Smith River	4	22.99	x	x	x	x	X	x	x	x	4	22.99
Coastal Klamath	6	35.35	16	52.46	x	x	X	x	x	x	22	87.81
Blue Creek	x	X	4	21.63	x	x	X	x	x	x	4	21.63
Interior Klamath	x	X	11	30.23	x	x	X	x	x	x	11	30.23
Redwood Creek	x	X	x	x	x	x	X	x	x	x	0	0
Coastal Lagoons	x	X	x	x	x	x	X	x	x	x	0	0
Little River	x	X	x	x	4	18.02	X	x	x	x	4	18.02
Mad River	3	11.29	x	x	x	x	X	x	x	x	3	11.29
NF Mad River	2	18.03	x	x	x	x	X	x	x	x	2	18.03
Humboldt Bay	1	7.04	x	X	x	x	3	7.04	x	x	4	14.08
Eel River	x	X	x	X	x	x	X	x	4	5.84	4	5.84
TOTALS	16	94.70	31	104.32	4	18.02	3	7.04	4	5.84	58	229.92

[1]California Conservation Corps
[2]California Department of Fish and Game

C1.2 RESULTS

Results of the channel and habitat typing assessments for the 58 streams are summarized in Tables C1-2 through C1-8. These results are discussed in more detail in the following discussion and conclusions section below.

C1.3 DISCUSSION

The following discussion is based on the results of the channel and habitat typing assessments presented in Tables C1-2 through C1-8.

Table C1-2. Stream assessment summaries for four Plan Area streams in the Smith River HPA.

Parameters	Streams			
	SF Winchuck River	**Dominie**	**Wilson**	**Rowdy**
Year Assessed	1995	1995	1994	1995
Assessed by	Green Diamond	Green Diamond	Green Diamond	Green Diamond
Total Length of Channel Assessed (feet)	31,961	17,118	35,640	36,668
Mean % Canopy Density	92	94	79	63
% deciduous	98	93	94	97
% conifer	2	7	6	3
% LWD as Structural Shelter in All Pools	6.4	18.2	21.8	5.6
Habitat Types as % of Total Length				
Riffles	41	51	25	24
Flat-water	32	29	41	42
Pools	27	20	28	33
Dry Channel	0	0	7	1
Pool Tailout Embeddedness as % Occurrence				
0-25%	27.3	0.5	37.0	32.5
26-50%	37.2	31.3	35.5	41.0
51-75%	19.1	21.5	28.0	17.5
76-100%	16.4	46.8	0.0	6.3
Maximum Pool Depths as % Occurrence				
<1' deep	0.6	0.9	0.0	20.4
1'-2' deep	4.3	53.7	5.9	2.0
2'-3' deep	40.2	41.7	39.1	7.1
3'-4' deep	39.6	3.7	27.2	33.7
>4' deep	15.2	0.0	27.8	36.7
Index of Embeddedness	3.5	3.1	3.3	2.6
Mid-point Gradient (%)	2.1	4.2	1.1	2.4
Mid-point Watershed Area (acres)	4,336	1,356	5,092	10,990

Table C1-3. Stream assessment summaries for 22 Plan Area streams the Coastal Klamath HPA.

Parameters	Streams							
	Hunter	**EF Hunter**	**High Prairie**	**Mynot**	**HPW**	**NF HPW**	**Terwer**	**EF Terwer**
Year Assessed	1994	1996	1996	1996	1996	1996	1994	1996
Assessed by:	Green Diamond	YTFP	YTFP	YTFP	YTFP	YTFP	Green Diamond	YTFP
Total Length of Channel Assessed (ft)	54,399	11,846	18,336	10,880	23,404	4,413	62,416	16,131
Mean % Canopy Density	80	88	80	76	90	95	36	71
% deciduous	93	93	77	85	91	73	75	95
% conifer	7	7	23	15	9	27	25	5
% LWD as Structural Shelter in all Pools	35	55.1	36.4	15.8	46.1	33.1	16.5	6.8
Habitat Types as % of Total Length								
Riffles	8.0	1	8	0	15	22	19.0	7
Flat-water	32.0	41	35	6	28	9	43.0	59
Pools	17.0	15	37	6	19	52	31.0	34
Dry Channel	43.0	44	19	86	38	14	7.0	0
Culvert	0	0	1	0	0	0	0	0
Pool Tailout Embeddedness as % Occurrence								
0-25%	24.7	0	2.3	0	1	0	31.3	9.0
26-50%	57.0	19	46.0	11	19.4	35	45.0	76.0
51-75%	18.2	47	49.4	79	69	63	21.3	15.0
76-100%	0	33	2.8	11	10.6	2	0	0
Maximum Pool Depths as % Occurrence								
<1' deep	0.0	1.8	9.7	21.1	5.0	10.4	0.5	1.6
1'-2' deep	8.0	56.1	55.7	57.9	70.5	60.4	1.5	48.4
2'-3' deep	38.3	31.6	27.8	15.8	22.7	29.2	19.8	36.3
3'-4' deep	32.5	8.8	6.1	0	1.8	2.1	28.9	9.3
>4' deep	21.4	1.8	1.0	5.3	0	0	49.2	4.4
Index of Embeddedness	2.7	2.9	3.0	3.0	1.6	2.6	2.5	1.6
Mid-point Gradient (%)	1.6	NA	3.6	NA	1.7	3.0	1.5	NA
Mid-point Watershed Area (acres)	4,898	1,031	2,134	526	1,012	522	8,602	3,523

Codes

HPW Hoppaw Creek
EF East Fork
NF HPW North Fork Hoppaw
NA Not applicable, or not available

Table C1-3 Continued. **Stream assessment summaries for 22 Plan Area streams in the Coastal Klamath HPA.**

Parameters	Streams							
	McG	**WF McG**	**Tarup**	**Omagar**	**APCM**	**APCS**	**APCN**	**A-P Trib**
Year Assessed:	1996	1996	1996	1996	1995	1995	1995	1997
Assessed by	YTFP	YTFP	YTFP	YTFP	Smpsn	Smpsn	Smpsn	YTFP
Total Length of Channel Assessed (feet)	29,085	13,033	26,343	13,276	17,299	8,284	26,669	3,132
Mean % Canopy Density	89	94	97	95	91	95	93	84
% deciduous	92	89	93	90	97	94	89	90
% conifer	8	11	7	10	3	6	11	10
% LWD as Structural Shelter in all Pools	37.8	41.2	25.4	43.4	15.1	35.8	9.6	27.1
Habitat Types as % of Total Length								
Riffles	4	6	10	10	28.0	46.0	37.0	6
Flat-water	25	20	19	39	31.0	29.0	29.0	54
Pools	69	73	71	26	17.0	24.0	25.0	39
Dry Channel	1	1	0	0	24.0	1.0	9.0	1
Culvert	0	0	0	23	0	0	0	0
Pool Tailout Embeddedness as % Occurrence								
0-25%	0.4	0	1.6	7.0	9.0	15.0	9.8	44.1
26-50%	15.5	2.7	26.5	51.0	33.3	23.0	19.3	55.9
51-75%	66.7	62	71.1	38.3	27.9	21.0	27.0	0
76-100%	17.7	35.5	0.9	3.7	24.9	41.0	43.7	0
Maximum Pool Depths as % Occurrence								
<1' deep	6.5	13.9		15.1	2.2	1.5	0.6	19.2
1'-2' deep	42.8	47.5	30.3	56.0	30.1	67.6	29.3	56.2
2'-3' deep	32.1	27	43.9	16.4	45.2	29.4	48.1	20.5
3'-4' deep	10.7	25	16.8	5.0	17.2	1.5	17.1	4.1
>4' deep	7.8	1.6	9.0	0.0	5.4	0.0	5.0	0.0
Index of Embeddedness	1.9	2.1	2.7	2.9	2.7	3.1	3.0	2.2
Mid-point Gradient (%)	1.8	2.7	5.6	3.9	1.7	4.5	2.1	5.6
Mid-point Watershed (acres)	1,672	1,296	1,971	773	2,573	1,290	2,437	1,076

Codes

McG	McGarvey Creek WF	McG	West Fork McGarvey Creek
APCN	North Fork Ah Pah Creek	APCM	Main stem Ah Pah Creek
A-P Trib	Tributary to Main stem Ah Pah	APCS	South Fork Ah Pah Creek

Table C1-3 Continued. **Stream assessment summaries for 22 Plan Area streams in the Coastal Klamath HPA.**

Parameters	Streams					
	Bear	**Bear (Trib 1)**	**Bear (Trib 2)**	**Surpur**	**Little Surpur**	**Tectah**
Year Assessed	1995	1996	1996	1996	1996	1996
Assessed by	Smpsn	YTFP	YTFP	YTFP	YTFP	YTFP
Total Length of Channel Assessed (feet)	17,581	7,102	4,242	18,046	11,072	66,632
Mean % Canopy Density	88	77	78	89	93	86
% deciduous	93	93	91	94	91	89
% conifer	7	7	9	6	9	11
% LWD as Structural Shelter in all Pools	19.8	9.8	22.7	13.2	18.2	14.6
Habitat Types as % of Total Length						
Riffles	58	14	3	4	0	6
Flat-water	24	53	64	23	33	44
Pools	16	33	31	73	61	48
Dry Channel	2	0	2	0	6	2
Culvert	0	0	0	0	0	0
Pool Tailout Embeddedness as % Occurrence						
0-25%	4.5	1.9	0.0	1.0	0.0	0.0
26-50%	22.3	79.4	73.0	36.0	31.3	68.0
51-75%	54.3	18.4	27.0	61.0	66.7	32.0
76-100%	19.0	0.0	0.0	3.0	2.1	0.0
Maximum Pool Depths as % Occurrence						
<1' deep	60.0	8.2	24.2	0.6	1.6	5.7
1'-2' deep	6.0	71.4	56.1	42.3	42.6	35.9
2'-3' deep	19.0	15.3	15.2	37.2	36	30.6
3'-4' deep	6.0	4.1	4.5	17.3	18.2	14.3
>4' deep	9.0	2.0	0.0	2.6	1.6	13.5
Index of Embeddedness	2.7	2.3	2.9	2.4	2.5	2.3
Mid-point Gradient (%)	3.4	4.2	NA	NA	4.0	NA
Mid-point Watershed (acres)	5,112	1.186	1.442	2.712	1.363	7,434

Table C1-4. Stream assessment summaries for four Plan Area streams in the Blue Creek HPA.

Parameters	Streams			
	Blue	**WF Blue**	**Potato Patch**	**Slide**
Year Assessed	1998	1995	1997	1997
Assessed by	YTFP	YTFP	YTFP	YTFP
Total Length of Channel Assessed	77,144	22,842	2,162	12,050
Mean % Canopy Density	42	87	95	38
% deciduous	66	94	90	23
% conifer	34	6	10	77
% LWD as Structural Shelter in all Pools	4.0	6.0	1.5	3.3
Habitat Types as % of Total Length				
Riffles	16	49	13	16
Flat-water	61	23	56	65
Pools	23	27	30	19
Dry Channel	0	1	0	0
Pool Tailout Embeddedness as % Occurrence				
0-25%	6.1	10.2	0.0	0.9
26-50%	75.1	31.3	28.7	65.3
51-75%	17.5	53.1	68.7	31.0
76-100%	1.3	4.7	2.7	2.8
Maximum Pool Depths as % Occurrence				
<1' deep	0.6	78.4	0	0
1'-2' deep	6.3	1.1	45.5	12.9
2'-3' deep	5.0	8.7	39.4	44.7
3'-4' deep	21.4	8.3	12.1	32.9
>4' deep	66.4	3.5	3.0	9.4
Index of Embeddedness	2.9	2,2	2,1	2,7
Mid-point Gradient (%)	2.0	6.1	5.7	6.6
Mid-point Watershed Area (acres)	38,563	4,372	2,820	3,414

Table C1-5. Stream assessment summaries for 11 Plan Area streams in the Interior Klamath HPA.

Parameters	Streams				
	Johnson	**Pecwan**	**EF Pecan**	**Mettah**	**SF Mettah**
Year Assessed	1996	1997	1997	1997	1997
Assessed by	YTFP	YTFP	YTFP	YTFP	YTFP
Total Length of Channel Assessed	11,906	4,239	1,836	36,801	8,482
Mean % Canopy Density	94	74	86	86	89
% deciduous	97	69	76	83	78
% conifer	3	31	24	17	22
% LWD as Structural Shelter in all Pools	9.3	1.7	4.3	10.3	19.9
Habitat Types as % of Total Length					
Riffles	3	14	16	10	12
Flat-water	24	62	30	51	64
Pools	60	24	54	40	24
Dry Channel	13	0	0	0	0
Pool Tailout Embeddedness As % Occurrence					
0-25%	0	0	0	0.0	0
26-50%	6.0	7.1	0	23	5.0
51-75%	93.0	92.9	100	76.6	92.0
76-100%	1.0	0	0	0.8	3.0
Maximum Pool Depths as % Occurrence					
<1' deep	4.2	0	0	4.7	0
1'-2' deep	46.9	19.0	10.0	56.5	54.1
2'-3' deep	33.3	33.3	35.0	27.7	38.8
3'-4' deep	11.5	33.3	30.0	8.4	7.1
>4' deep	4.2	14.3	25.0	2.9	0
Index of Embeddedness	3.0	3.0	3.0	2.8	3.0
Mid-point Gradient (%)	NA	3.5	4.1	2,8	3.0
Mid-point Watershed Area (acres)	1,307	17,574	8,401	2,959	1,558

Table C1-5 Continued. **Stream assessment summaries for 11 Plan Area streams in the Interior Klamath HPA.**

Parameters	Streams					
	Roach	**Roach (Trib)**	**Morek**	**Cappel**	**Tully**	**Robbers Ck**
Year Assessed	1997	1997	1997	1997	1997	1997
Assessed by	YTFP	YTFP	YTFP	YTFP	YTFP	YTFP
Total Length of Channel Assessed	38,876	6,235	2,060	3,529	41,995	3,643
Mean % Canopy Density	78	80	85	79	79	84
% deciduous	70	73	66	59	92	92
% conifer	30	27	34	41	8	8
% LWD as Structural Shelter in all Pools	3.5	16.6	6.4	5.7	12.7	10.5
Habitat Types as % of Total Length						
Riffles	4	2	22	27	5	8
Flat-water	48	41	45	31	70	52
Pools	45	53	21	42	24	31
Dry Channel	3	3	13	0	2	1
Pool Tailout Embeddedness As % Occurrence						
0-25%	0	0	0	0	27.6	4.8
26-50%	0	0	16.6	2.0	54.6	32.1
51-75%	100	100	83.4	98.0	0	63.2
76-100%	0	0	0	0	0	0
Maximum Pool Depths as % Occurrence						
<1' deep	1.1	0	9.0	2.3	0.8	6.2
1'-2' deep	30.6	52.4	40.1	14.0	28	43.7
2'-3' deep	30.6	30.2	45.4	65.1	41.4	37.4
3'-4' deep	21.0	12.7	4.5	14.0	19.2	10.4
>4' deep	16.7	4.8	0	4.7	10.7	2.1
Index of Embeddedness	2.4	3.0	2.8	3.0	1.9	3.0
Mid-point Gradient (%)	2.2	2.6	4.7	7.0	4.1	5.0
Mid-point Watershed Area (acres)	10,808	3,548	2,562	5,312	7,264	2,106

Table C1-6. Stream assessment summaries for four Plan Area streams in the Little River HPA.

Parameter	Streams			
	USFLR	**LSFLR**	**RR**	**LR**
Year Assessed	1994	1994	1994	1994
Assessed by	L-P	L-P	L-P	L-P
Total Length of Channel Assessed (feet)	10539	14998	7,262	62,373
Mean % Canopy Density	99	98	98	91
% deciduous	76	67	69	84
% conifer	24	33	31	16
% LWD as Structural Shelter in All Pools	25.9	38.5	26.6	17.3
Habitat Types as % of Total Length				
Riffles	32	30	37	19
Flat-water	20	11	7	25
Pools	45	56	46	53
Dry Channel	3	3	10	3
Pool Tailout Embeddedness as % Occurrence				
0-25%	21.7	14.2	10.5	8.1
26-50%	44.0	46.3	49.2	41.1
51-75%	17.2	31.4	31.9	38.7
76-100%	16.6	8.3	8.1	12.1
Maximum Pool Depths as % Occurrence				
<1' deep	6.8	5.0	26	2.7
1'-2' deep	49.5	43.4	50.0	20.4
2'-3' deep	31.8	31.4	18.7	26.8
3'-4' deep	6.8	7.5	4.4	26
>4' deep	4.5	12.6	1.1	23.6
Index of Embeddedness	2.3	2.3	1.9	3.2
Mid-point Gradient (%)	3.1	1.6	2.9	3.0
Mid-point Watershed Area (acres)	3,095	2,611	1,205	9,475

Codes

USFLR	Upper South Fork Little River
LSFLR	Lower South Fork Little River
RR	Railroad Creek
LR	Mainstem Little River
NA	Not applicable or not available

Table C1-7. Stream assessment summaries for five Plan Area streams in the Mad River HPA and North Fork Mad River HPA.

Parameter	Mad River HPA			North Fork Mad River HPA	
	Streams			Streams	
	CC	DC	LC	NFMR	LPC
Year Assessed	1994	1994	1995	1994	1994
Assessed by	Smpsn	Smpsn	Smpsn	Smpsn	Smpsn
Total Length of Channel Assessed (feet)	24,862	4,512	30,227	80,278	14,928
Mean % Canopy Density	81	92	79	73	95
% deciduous	85	75	79	95	87
% conifer	15	25	21	5	13
% LWD as Structural Shelter in All Pools	16.7	14	26.9	12.1	10.4
Habitat Types as % of Total Length					
Riffles	26	67	9	11	47
Flat-water	27	14	41	38	23
Pools	47	16	50	42	30
Dry Channel	0	3	0	10	0
Pool Tailout Embeddedness as % Occurrence					
0-25%	16.7	30.5	3.0	18.1	6.0
26-50%	41	40.8	16.0	19.3	21.3
51-75%	32.1	18.3	22.0	28.6	20.9
76-100%	11.2	11.1	60.0	33.6	51.9
Maximum Pool Depths as % Occurrence					
<1' deep	1.0	6.1	0.4	07.4	3.5
1'-2' deep	19.6	78.8	12.7	10.7	41.6
2'-3' deep	39.0	9.1	38.3	33.6	39.8
3'-4' deep	22.7	3.03	32.8	26.6	12.6
>4' deep	17.6	3.03	15.6	28.2	2.3
Index of Embeddedness	2.4	2.1	3.4	2.8	2.5
Mid-point Gradient (%)	3.0	3.7	1.0	1.4	2.6
Mid-point Watershed Area (acres)	8,595	1,492	2,985	11,273	4,592

Codes

DC	Dry Creek	NFMR	North Fork Mad River
CC	Cañon Creek	LPC	Long Prairie Creek
LC	Lindsay Creek	NA	Not applicable or not available

Table C1-8. Stream assessment summaries eight Plan Area streams in the Humboldt Bay HPA and Eel River HPA.

Parameter	Humboldt Bay HPA				Eel River HPA			
	Streams				Streams			
	RC	RC(a)	RC(b)	SC	WC	ST	HW	WFH
Year Assessed	1995	1995	1995	1994	1991	1991	1998	1998
Assessed by	CCC	CCC	CCC	Smpsn	CDFG	CDFG	CDFG	CDFG
Total Length of Channel Assessed (feet)	27,682	1,139	8,342	37,153	2,481	5,063	20,975	2,342
Mean % Canopy Density	94	90	88	88	80	67	57	86
% deciduous	68	NA	NA	83	83	71	81	95
% conifer	32	NA	NA	17	17	29	19	5
% LWD as Structural Shelter in all Pools	49.1	17.1	39.8	27.5	10.0	48.2	4.0	0.0
Habitat Types as % of Total Length								
Riffles	5	3	1	27	86	33	65	74
Flat-water	29	16	37	29	10	37	29	18
Pools	65	81	61	44	4	26	6	7
Dry Channel	1	0	0	0	0	5	0	0
Pool Tailout Embeddedness as % Occurrence								
0-25%	7.5	NS*	NS*	9.8	0	63.8	0.9	0.0
26-50%	22.4			24.5	17.8	17.7	22.3	18.0
51-75%	33.5			34.5	17.8	17.3	62.3	73.0
76-100%	36.6			30.6	64.4	1.1	13.8	9.0
Maximum Pool Depths as % Occurrence								
<1' deep	6	19	2.9	0.6	0.0	0.0	0.0	0.0
1'-2' deep	44.8	54.8	43.8	12.6	83.3	43.1	42.0	81.8
2'-3' deep	30.7	19	35.1	42.5	16.7	39.4	52.0	18.2
3'-4' deep	12.2	7.1	13.9	26.5	0.0	10.6	3.8	0.0
>4' deep	6.2	0.0	4.3	17.9	0.0	7.3	2.3	0.0
Index of Embeddedness	3.0	3.0	4.0	2.8	2.9	2.3	2.4	1.9
Mid-point Gradient (%)	1.0	1.0	1.0	1.0	2.6	3.3	2.1	7.0
Mid-point Watershed Area (acres)	3,669	662	1,293	5,399	1,250	3,308	2,594	3,372

Codes

RC Ryan Creek
RC(a) 1st unnamed trib to RC
RC(b) 2nd unnamed trib to RC
SC Salmon Creek
NS* The CCC judged these pools as 'Not suitable for spawning', and did not record pool tailout embeddedness values.

WC Wilson Creek
ST Stevens Creek
HW Howe Creek
WFH West Fork Howe Creek
NA The value was either not recorded or not applicable

C1.3.1 Mean Percent Canopy Closure and Percent Canopy Cover

The mean percent canopy closure along each assessed stream as a function of watershed area is shown as Figure C1-1. The percentage of canopy closure along stream channels is important for the regulation of water temperatures and as a source of nutrients for the aquatic organisms. This assessment also provides information about the species (conifer, deciduous) composition of the riparian zone.

The mean canopy closure in the 58 assessed streams ranged from 36% in Terwer Creek ([Coastal Klamath HPA] Table C1-3), to 99% in Upper South Fork of Little River ([Little River HPA] Table C1-6) and are shown in Figure C1-1. CDFG's Salmonid Restoration Manual recommends that a mean canopy closure of approximately 80% is required/desirable to maintain suitable summer water temperatures for juvenile coho salmon (Flosi and Reynolds 1994). From the assessments conducted 69% of the streams assessed (40 of 58) had mean canopy closures greater than or equal to 80% (Figure C1-1). As shown in this figure the mean canopy closure percentage diminishes with increased stream watershed size.

The percent canopy cover by type (deciduous and conifer) for the assessed streams are shown in Tables C1-2 through C1-8. The mean percent conifer closure plotted against watershed area is shown as Figure C1-2. The percent of conifer cover ranged from a low of 2% in the South Fork Winchuck River ([Smith River HPA] Table C1-2) to 77% on Slide Creek ([Blue Creek HPA] Table C1-4) and are shown in Figure C1-2. As shown in Figure C1-2, deciduous trees dominated the riparian canopy of the assessed streams, with most of the streams (67%) containing less than 20% conifers along the riparian margin. As shown in the figure, there is a trend with a slightly larger percentage of conifer canopy in larger watersheds as compared to smaller watersheds.

C1.3.2 Percent LWD as Structural Shelter in Pool Habitats

To assess habitat complexity, the dominant structural shelter element and the contribution of other shelter components was determined on a percent basis for each habitat type. LWD is an important shelter component that facilitates numerous functions within certain channel types. LWD is a pool-forming component that adds complexity and cover to stream channels. The percentage of in-channel LWD as shelter should reflect the quantity and quality of potential salmonid habitat and possibly the effects of past management practices.

The results of assessment of LWD as structural shelter in all pools surveyed as part of the habitat assessments are summarized in Tables C1-2 through C1-8. LWD as structure in pools in the assessed streams are shown by watershed area in Figure C1-3. As shown in Figure C1-3, the percentage of LWD as shelter was greatest in stream pools. The percentage of LWD as shelter in pools ranged from a low of 0% in West Fork Howe Creek ([Eel River HPA] Table C1-8) to a high of 55% in East Fork Hunter Creek ([Coastal Klamath HPA] Table C1-3).

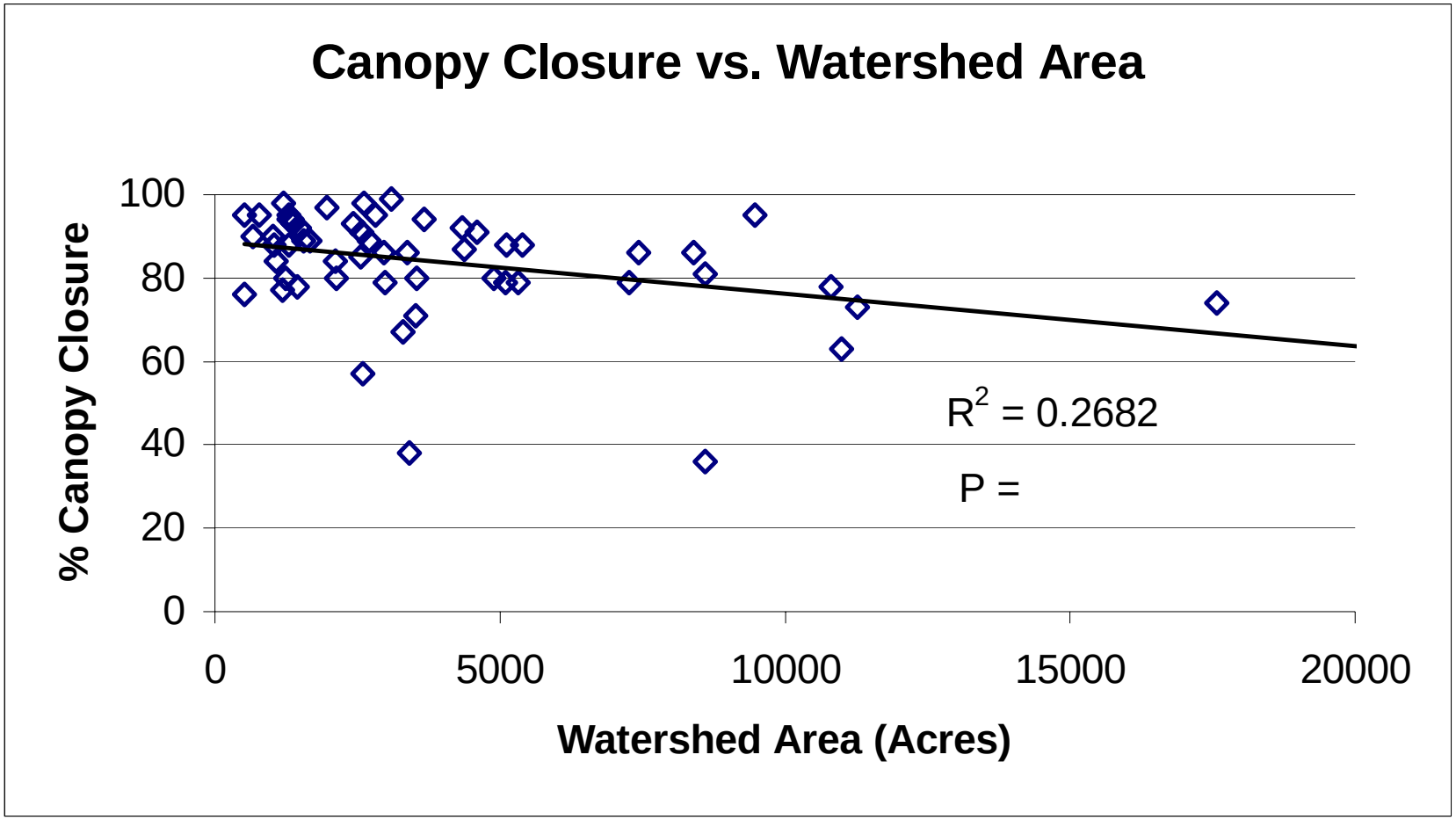

Figure C1-1. Canopy closure versus watershed area for all assessed streams in which habitat typing surveys were conducted.

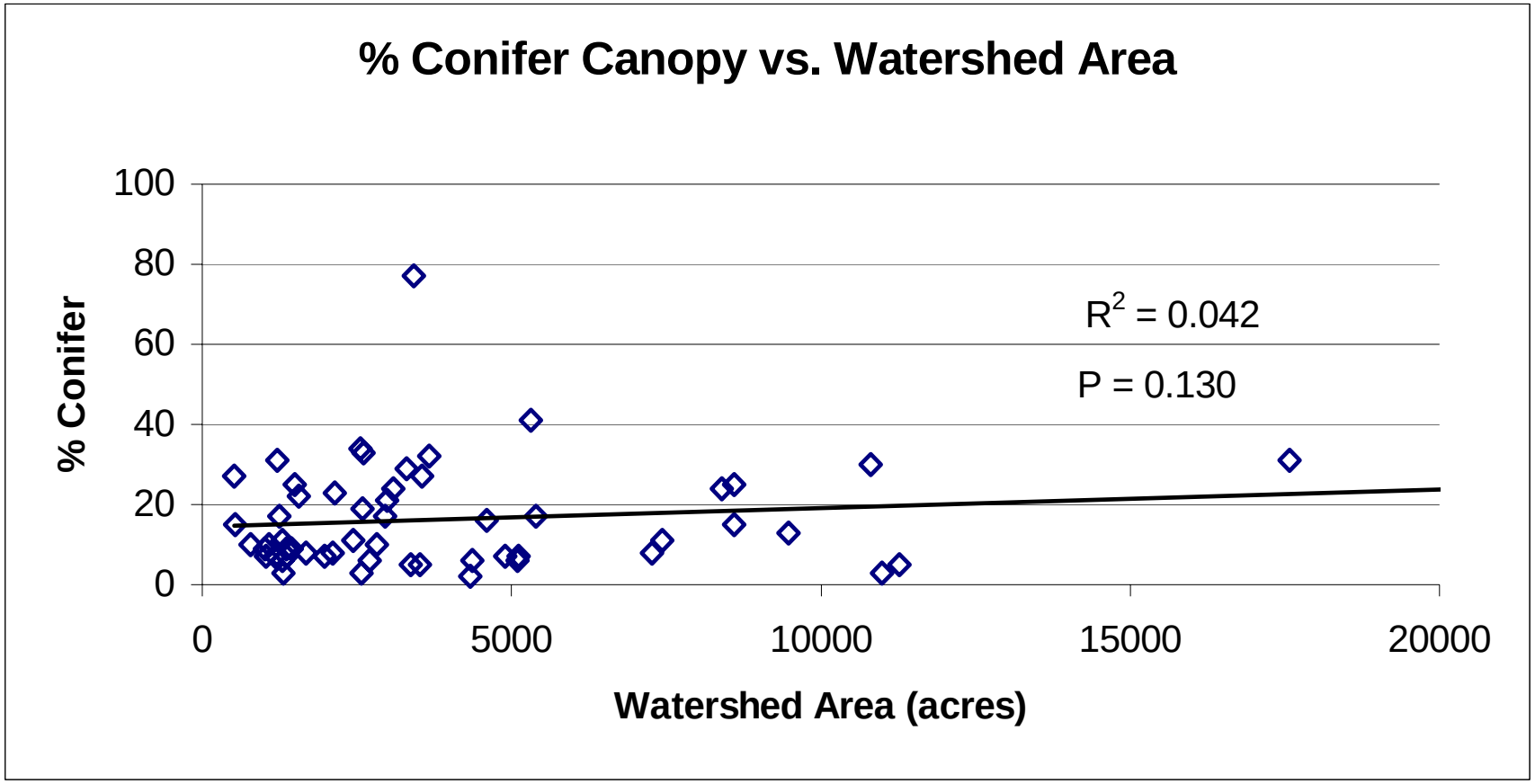

Figure C1-2. Percent conifer canopy versus watershed area for all assessed streams in which habitat typing surveys were conducted.

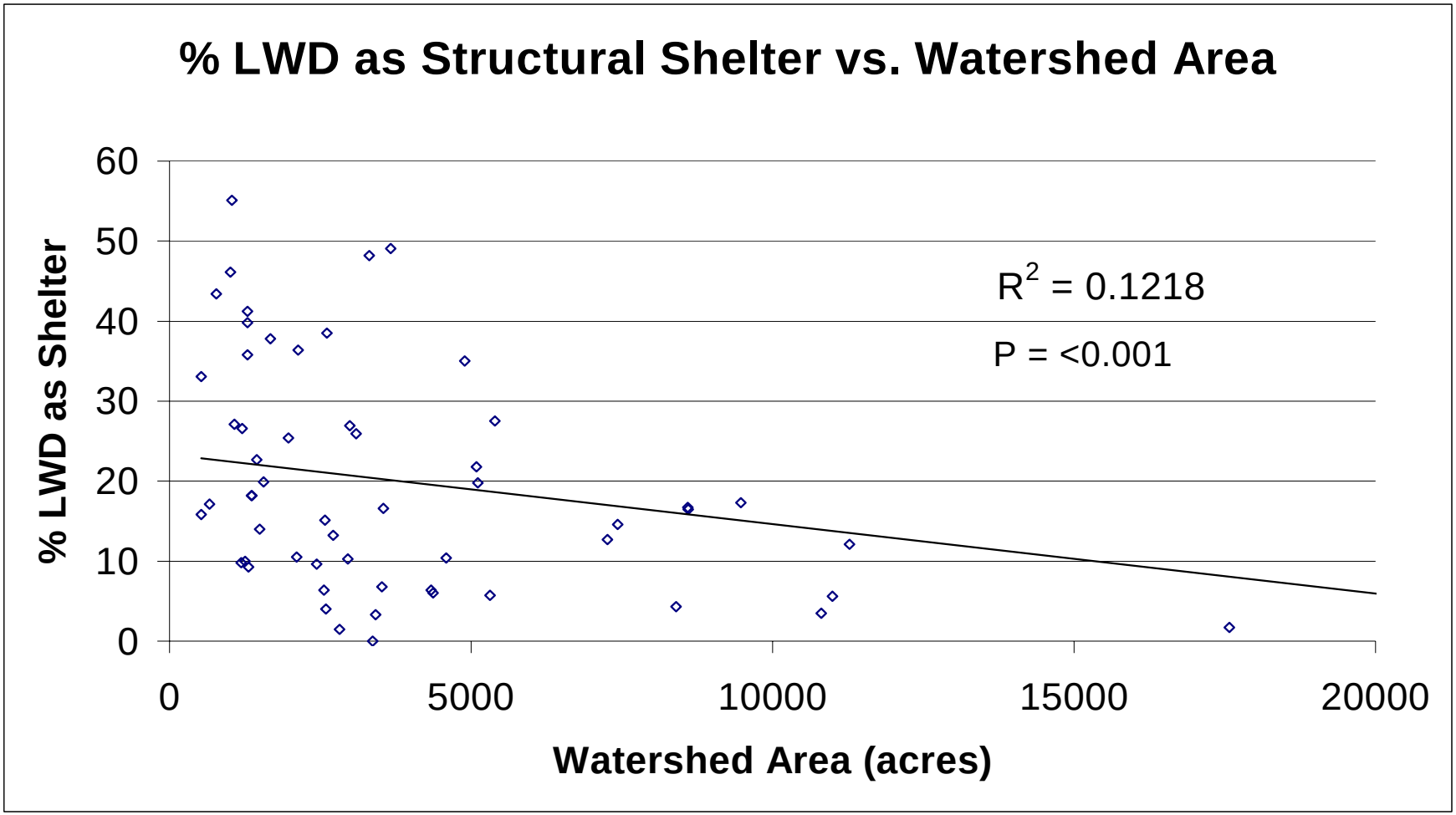

Figure C1-3. Percentage of LWD as structural shelter versus watershed area for the assessed streams.

East Fork Hunter Creek was the only stream assessed in which LWD was the dominant (>50%) structural cover. Two additional streams, Ryan Creek ([Humboldt HPA] Table C2-7) with 49%, and Stevens Creek ([Eel River HPA] Table C1-8) with 48% had nearly 50% LWD as structural cover. Of all 58 of the streams assessed, approximately 36% (21 of 58 streams) had LWD as a structural shelter component greater than 20% of all in-stream cover present (Figure C1-3). As shown in that figure there is generally a trend of lower percentages of LWD as structural shelter in pools within streams with larger watershed areas.

The relatively higher amounts of LWD as structural shelter in Hunter Creek, Ryan and Stevens Creeks are probably due to past management practices which retained some riparian cover and also did not aggressively clear the channel of LWD. These watersheds may additionally have some inherent geologic instability that still provides episodic inputs of LWD and sediments to their channels. The lower percentages of LWD in the North Fork Mad River can be attributed to extensive clearing of LWD from the channel. Historic photographs from the mid-1950's show sections of channel clogged with immense jams of logging slash and giant pieces of redwood LWD. Presently, these same sections of channel are nearly devoid of LWD as a result of aggressive stream cleaning efforts during the late 1960's and 1970's. At the time, clearing stream channels of debris jams was deemed by the best available information as a means of fisheries restoration (stream cleaning was also a response to the damage incurred to bridges and roads by debris during the 1955 and 1964 floods). Unfortunately many of these efforts went far beyond improving fish passage and removed what are now regarded as vital habitat components.

C1.3.3 Habitat Types as a Percent of Total Length

Level II (Flosi and Reynolds 1994) partitioning of habitat units separates the stream channel into riffles, flat-water, pools and dry channel. Generally, forming conclusions about the relative health of a stream with respect to salmonids from a level II partitioning of habitat units is difficult. Local geology, channel type, water level, and channel gradient will all influence the relative proportions of each habitat type. However, an extremely high proportion of a certain habitat unit may indicate a channel response to major (either natural or management influenced) watershed disturbances.

Excessive aggradation of stream reaches may lead to a high proportion of riffle habitat as well as an increase in seasonal stretches of dry channel as pools and runs get filled in with sediment. Intermittence is common in steep mountainous watersheds where a majority of the channel is confined and sediments are transported through these areas and are deposited on the wide, low gradient reaches near the mouths. Depending on the watershed this aggradation of sediment can be quite extensive. During low flow conditions the stream will go sub-surface, percolating through the sediment deposits. Many stream channel segments assessed were dry during the assessment surveys.

The summary of the habitat types as a percent of total length of each assessed stream and plotted by watershed area are shown in Tables C1-2 through C1-8. Of the 58 streams evaluated, there were 59% (34 out of 58) which had at least 1% of their total length of stream channel classified as dry channel. Three streams had greater than 40% of their total channel classified as dry: Hunter Creek (43%), East Fork Hunter Creek (44%) and Mynot Creek (86%) all within the Coastal Klamath HPA (Table C1-3).

Many watersheds within the Plan Area exhibit this naturally occurring phenomenon. However, the increased sediment loads from hillslope failures often associated with logging activities and road construction can amplify the spatial and temporal extent of intermittency (Hicks et al. 1991). The impact of intermittency on salmonid populations has not been quantified, but probably affects the out-migration of juveniles or may result in the stranding of juveniles in isolated pools where they would be susceptible to threshold temperatures and increased predation.

For the streams assessed, the percent of stream length of pools ranged from 4% in Wilson Creek ([Eel River HPA] Table C2-8) to 81% in Ryan Creek ([Humboldt Bay HPA] Table C2-7). The percent of stream length of pools by watershed area are shown in Figure C1-4. As shown in Figure C1-4 the percentage of stream length of pools were widely variable in smaller watersheds (less than 5000 acres). For the 58 streams assessed, the percent of total stream length of riffles ranged from 0% in Mynot Creek and Little Surper Creek ([Coastal Klamath HPA] Table C1-3) to 86% in Wilson Creek ([Eel River HPA] Table C1-8). The percentage of stream length of flat-water habitats ranged from 6% in Mynot Creek ([Coastal Klamath River HPA] Table C2-3) to 70% in Tully Creek in the Interior Klamath River HPA (Table C1-4). The trend is that as watershed size increases beyond 5,000 acres, the variability in pool lengths as a total of stream length decreases.

C1.3.4 Pool Tail-out Embeddedness as Percent Occurrence

Summary of pool-tail out embeddedness estimates are shown in Tables C1-2 through C1-8. The embeddedness of channel substrate in pool tail-outs is a gross indication of the amount of fines present in spawning gravels which, in turn, may reduce the survival to emergence of salmonid alevins. However, the measurement is subjective and probably not accurately repeatable. If embeddedness was considered high (>50%), a more rigorous monitoring of substrate composition may be warranted to document amount of fines within pool tail-outs. Of the 58 assessed streams, 60% (35 out of 58) had embeddedness occurrences greater than 50%. From these assessments, 3 streams: East Fork Pecwan, Roach Creek, and a tributary to Roach Creek (all in the Interior Klamath HPA) had pool tail-out embeddedness occurrences of 100%.

An index of Pool tail-out embeddedness as a function of stream gradient for the assessed streams is shown in (Figure C1-5). Using embeddedness index categories of 1 through 4 which correspond to estimates of percent embeddedness of: 0-25% =1; 26-50% = 2; 51-75% = 3; and 76-100% = 4 the streams were categorized as shown in Figure C1-5 (Flosi et al. 1998). As shown in Figure C1-5 the estimated embeddedness for all Plan Area streams assessed generally were found to fall within the range of Index values of 2 to 3 regardless of stream gradient and the average index rating only diminished slightly for streams with larger watersheds.

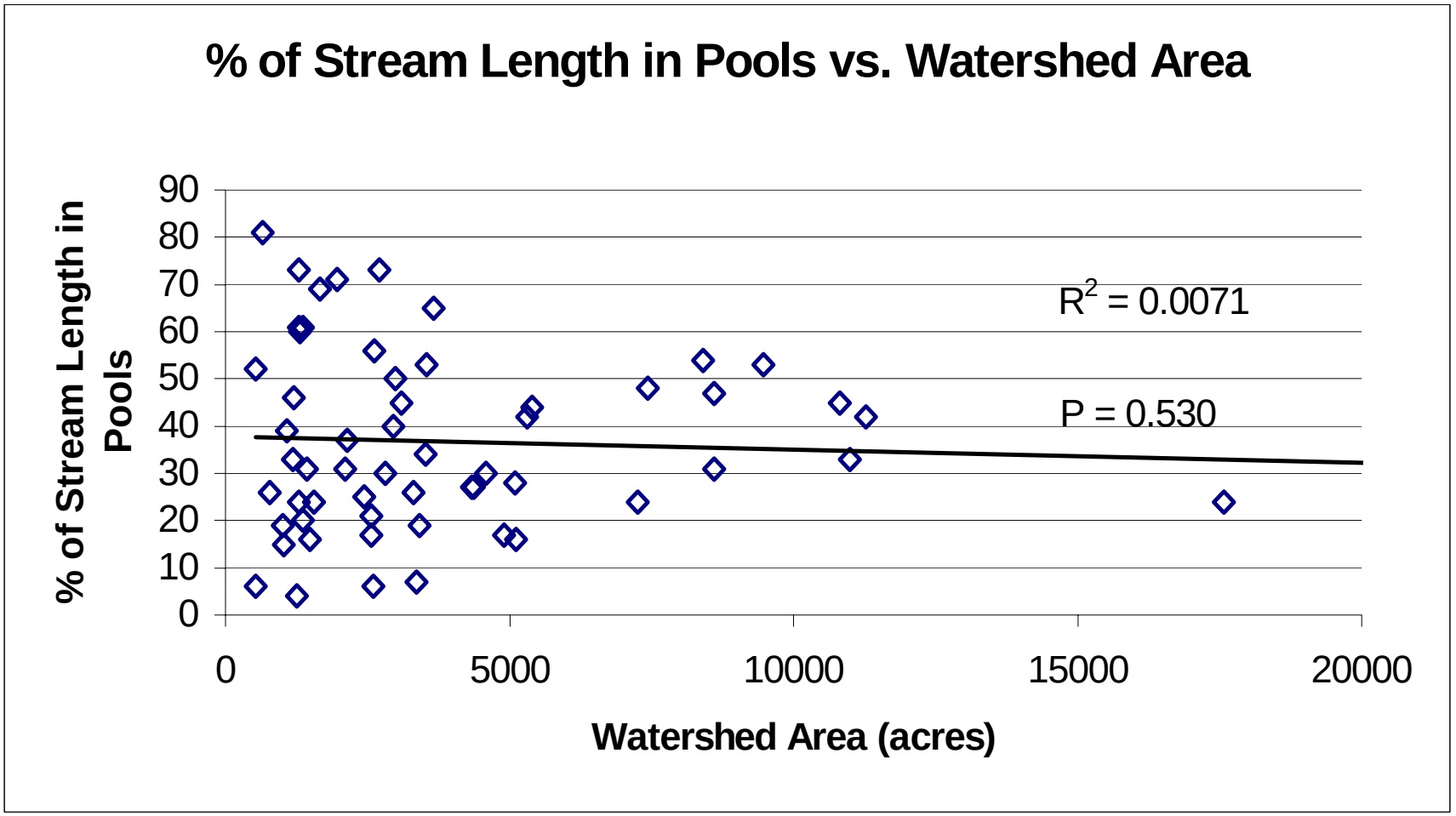

Figure C1-4. **Percent of stream length in pools plotted by watershed area for all streams assessed during the habitat assessments.**

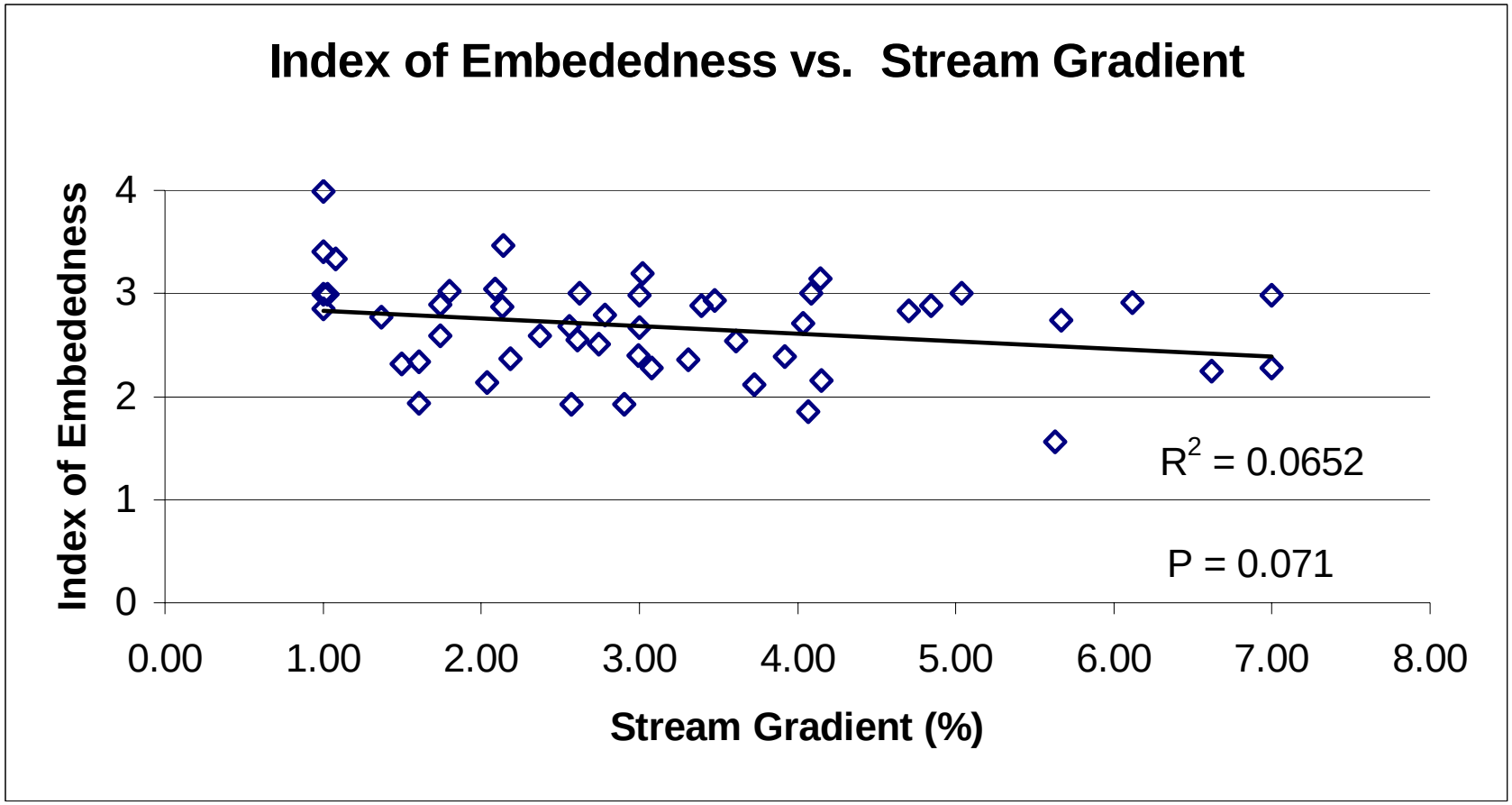

Figure C1-5. Index of streambed embeddedness as a function of stream gradient for all assessed streams.

C1.3.5 Maximum Residual Pool Depth as Percent Occurrence

Maximum pool depths are used by CDFG to calculate the percentage of primary pools, which are known to provide critical summer habitat for juvenile coho and steelhead under low flow conditions (Flosi et al., 1998). From CDFG's habitat typing assessments, there are indications that the better coastal coho streams may have as much as 40% of their total habitat length in primary pools (Flosi et al., 1998). A primary pool in a third order or larger stream would be expected to have a depth of three feet or greater. A primary pool in a first and second order stream is considered to be a depth of 2 feet or greater (Flosi and Reynolds 1994). Watershed area may be a confounding factor in comparing this variable, as smaller drainages with lower discharges tend to have shallower pools.

A summary of the residual pool depths for all assessed streams is shown in Tables C1-2 through C1-8. Of the 58 streams assessed, 14 (24%) had greater than 40% of their total pool habitat in primary pools (residual depths greater than 3') (Figure C1-6). These included three creeks that had in excess of 70% of their pools greater than 3' in depth: Rowdy Creek ([Smith River HPA] 70.4%), Terwer Creek ([Interior Klamath River HPA] 78.1%), and Blue Creek ([Blue Creek HPA] 87.8%) (Figure C1-6). On the average, the mean maximum residual pool depth was 2 feet for the assessed streams. In general, the streams with larger watershed areas contain deeper pools, on the average, than those with smaller watershed areas. Most of the assessed streams are in small drainages and are smaller than third order streams. Pools with residual depths greater than 2 feet or greater in many of these small streams may act as primary pools and provide temperature refugia. If these pools were considered as primary pools, functioning as summer habitat for juvenile salmonids during low flow conditions, then 71% of the assessed streams (41 out of 58) have greater than 40% of their pools classified as primary pools. Twenty-one percent of total streams assessed (12 out of 58 streams), have over 80% of their total pools greater than 2' in depth (Figure C1-6).

C1.4 CONCLUSIONS

The stream channel and habitat typing assessments indicated that habitat conditions for salmonids varied significantly among and within the 58 assessed streams. Taken together, the assessments suggested that there were:

1. A lack of complex pool habitat with low levels of LWD as shelter;

2. Dense, alder dominant riparian zones that provided excellent canopy closure, yet lacked the LWD recruitment potential of larger, more persistent, conifers;

3. Embedded gravels in many pool tails; and

4. Aggraded conditions in the lower reaches of some streams.

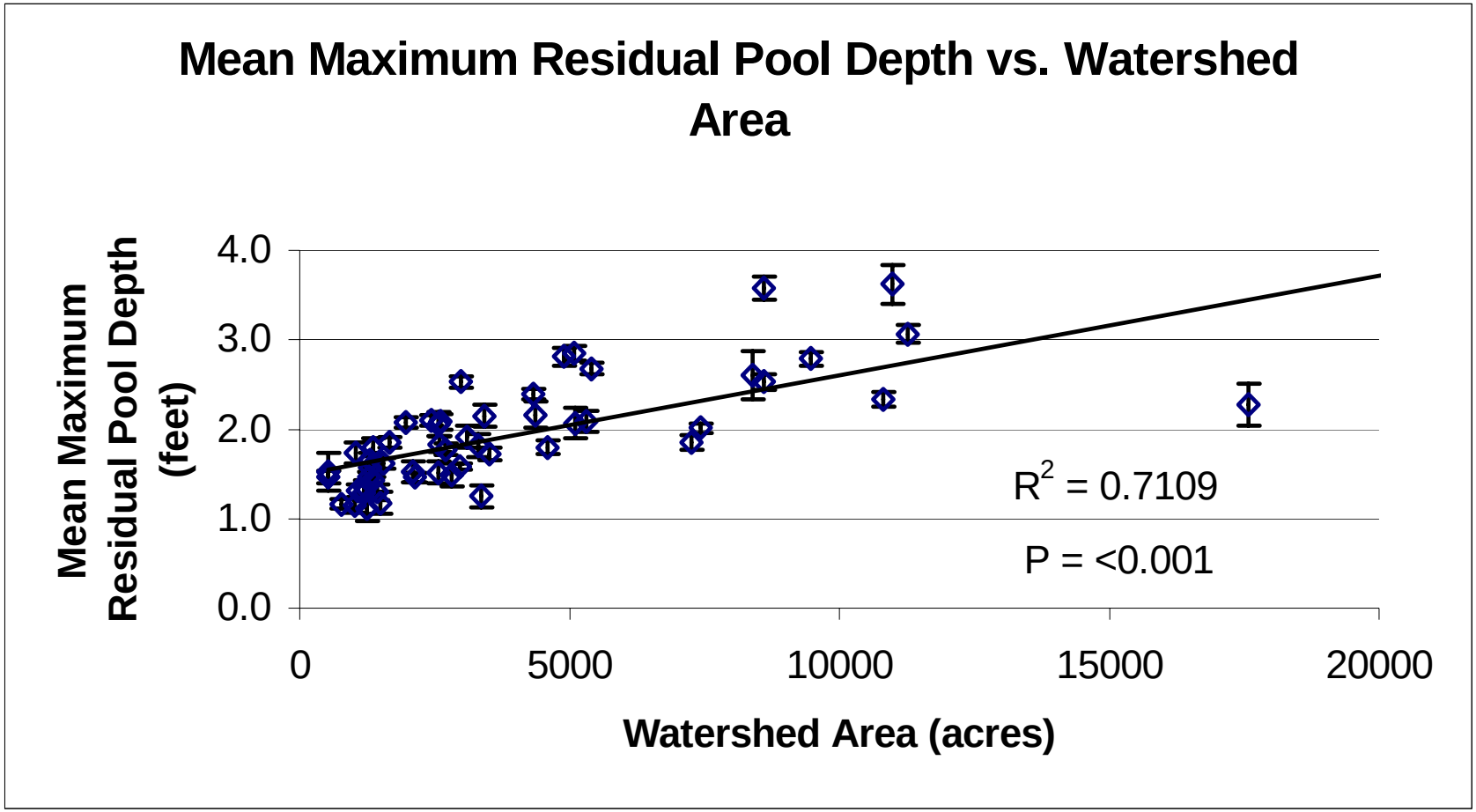

Figure C1-6. **Mean maximum pool depths plotted against watershed acres for the assessed streams. Error bars represent plus or minus one standard error.**

C1.5 REFERENCES

Flosi, G. and F.L. Reynolds. 1994. California salmonid stream habitat restoration manual. Second Edition. IFD, CDFG, Sacramento, CA.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual. Third Edition. IFD, CDFG, Sacramento, CA.

Hicks, B.J., J.D. Hall, P.A. Bisson and J.R. Sedell. 1991. Responses of salmonids to habitat changes. American Fisheries Society Special Publication 19:483-518.

Hopelain. 1995. California salmonid stream habitat restoration manual. IFD, CDFG, Sacramento, CA.