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HABITAT ANALYSIS FOR THE SANTA YNEZ RIVER

EXHIBIT CT 36

Prepared for:

SANTA YNEZ RIVER CONCENSUS COMMITTEE

Prepared by:

Santa Ynez River Technical Advisory Committee

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The waters of the Santa Ynez River are put to a variety of uses, including the maintenance of public trust resources both within Lake Cachuma and downstream of Bradbury Dam, as well as consumptive urban and agricultural uses within the Santa Ynez Valley and along the coastal plain encompassing the City of Santa Barbara and its urban environs. Since 1993, the U.S. Bureau of Reclamation, California Department of Fish and Game (CDFG), U.S. Fish and Wildlife Service (FWS), and various water project operators have been party to a "Memorandum of Understanding (MOU) for Cooperation in Research and Fish Maintenance" on the Santa Ynez River, downstream of Bradbury Dam ("lower river"). Parties to the MOU maintain a Technical Advisory Committee (TAC) whose ultimate goal is to "develop recommendations for long term fishery management, projects and operations" in the lower river.

The TAC was established in response to State Water Resources Control Board (SWRCB) actions dealing with Bradbury Dam and the lower Santa Ynez River that culminated in the SWRCB requesting flow recommendations for maintenance of public trust resources in the lower river. It was also established to broaden the scope of management options potentially available to protect public trust resources within the lower river, to attempt to accommodate the needs of all interested parties, and ultimately develop mutually acceptable management actions. Since 1993, the TAC has worked from year to year to undertake a variety of studies of the lower river. These studies have included: (i) water temperature and dissolved oxygen (DO) monitoring in Lake Cachuma and in the lower river from the stilling basin below Bradbury Dam to the lagoon; (ii) habitat quality evaluations in both the lower river and its tributaries; (iii) flow requirements for fish passage in the lower river; and (iv) fish population surveys in both the lower river and its tributaries (SYRTAC 1994, 1995).

Over time, the parties and the SWRCB recognized a need for a longer-term study plan to provide additional technical information to policy makers. In March 1996, the Consensus Committee approved a long-term study plan developed by the TAC Biology Subcommittee

(SYRTAC 1996). The plan provides the overall framework for the TAC studies, which are devoted to acquiring technical information regarding:

1. The diversity, abundance, and condition of existing public trust fishery resources within the lower river;
2. Conditions which may limit the diversity, abundance, or condition of public trust fishery resources within the lower river;
3. Non-flow measures which could be expected to improve the conditions that currently act to limit the diversity, abundance, or condition of public trust fishery resources within the lower river; and
4. Alternatives to the existing operational regime of the Cachuma Project which could be expected to improve the conditions that currently act to limit the diversity, abundance, or condition of public trust fishery resources within the lower river.

This report addresses the issue of habitat availability and quality changes with respect to flow in the mainstem Santa Ynez River below Bradbury Dam (as listed in part of Item 2, above).

This study is identified as Job 3 in the 1997 revision of the Proposed Investigations report (SYRTAC 1997). The specific objective of this report is to determine the relationship between streamflow and habitat quantity and quality for each fish species life-stage function, using modeling and empirical data. This document addresses the effects of flow on rearing habitat. Included are a description of the methods used, the results of these investigations and a discussion of the implications of these results for steelhead management in the mainstem Santa Ynez River. Fish passage, also part of Job 3, is addressed in a separate report.

In 1996, the SYRTAC implemented a study led by CDFG to determine how stream habitat varies with flow in the Santa Ynez River. The study was designed to evaluate changes in the top width of the river (the wetted width of the channel) with changes in stream flow releases from Bradbury Dam. Additional parameters to be considered in this study included water depth at the deepest portion of the flowing channel (the thalweg) and the mean column velocity associated with this portion of the channel (the thalweg velocity). The study was set up to evaluate how these parameters changed in the primary habitat types of importance, with habitat types being riffles, runs, glides, and deep pools.

This report describes the methods used in this study, the results of the study, and provides a brief discussion of the implications of these results for steelhead management.

Two data sets were used to develop habitat flow relationships in three reaches of the Santa Ynez River. These reaches are: (1) the Alisal Reach, near the Alisal Road bridge; (2) the Refugio Reach, upstream of the Refugio Road bridge; and (3) the Highway 154 Reach which extends from Highway 154 to Bradbury Dam. In the first two reaches, empirical data was collected as described below. In the Highway 154 reach, it was not possible to obtain permission to access the river from the land owners, and therefore the IFG-4 models developed by Department of Water Resources (DWR) (1989) were used to generate the measurements collected in the other reaches.

A total of 23 individual habitat units (pool, riffle, run, glide) were selected for a habitat/flow relationship study in the Refugio and Alisal Reaches of the Santa Ynez River. Each habitat unit was surveyed at flow levels of 50 cubic feet per second (cfs), 35 cfs, 20 cfs, and 10 cfs (release levels from Bradbury Dam), although the flows at the habitat units were generally less than this due to groundwater recharge of the released flows. Each habitat unit was measured for length, and between 3 to 10 transects were placed in each unit perpendicular to the flow. Transect endpoints were marked by driving ½-inch rebar into the substrate on each bank outside of the wetted channel at the highest flow measured. The distance between the two headpins was noted during the first set of data collected (at 50 cfs) and matched during subsequent measurements to facilitate precise collection of data. At this time, the distance of the thalweg from the left bank headpin was also determined, and at each subsequent release level the water surface elevation, depth, and velocity measurements were taken at the same location. During each measurement, top width (the width of the wetted channel) was determined from the tape. Water surface elevation and thalweg bed elevation were surveyed in using an automatic level and standard surveying techniques. Mean column velocity was taken to the nearest 0.05 feet per second (fps) at the thalweg using a Marsh McBirney Model 2000 current meter and a top set wading rod. This measurement was taken as the water velocity at 60 percent of the total depth if water depth was less than 2.5 feet, or as the average of the water velocities at 20 and 80 percent of the total depth if the depth was greater than 2.5 feet. These velocity measurements are referred to as thalweg velocities in the remainder of this document. River flow was measured upstream of survey locations during each day data were collected.

During data reduction and analysis, pools were separated into deep and shallow pools. A pool was placed in the shallow pool category, if no transect within that habitat unit had a thalweg depth of more than 3 feet at a flow of 10 cfs. The empirical data collected above were log transformed and log-log linear regression equations were generated between stream flow release and top width, thalweg depth, and thalweg velocity for each transect. From this function, the top width, thalweg depth, and thalweg velocity was determined at 1.5 and 3 cfs, and at 5 cfs intervals from 5 to 50 cfs. To be considered acceptable for further evaluation, the regression equations were required to have a positive slope and a r-squared value of 0.8 or greater. The values produced by these equations were checked against the field data for accuracy and only those regressions that reproduced velocity or depth values within 0.1 fps, or 0.1 feet, or wetted perimeter values within 2 feet were accepted. The individual predictions for each predicted value of a parameter were then averaged by reach and habitat type to produce the final functions for each parameter.

In the area of the Santa Ynez River between Highway 154 and Bradbury Dam, a similar habitat analysis in this area was conducted based on the IFIM models originally produced by DWR and re-calibrated by ENTRIX (1995). Output from the hydraulic models was used to determine the top widths, thalweg depths, and thalweg velocities at simulated target flows described above. In this analysis, the target flows were the flow at the transect and not the flows being released from the dam.

The data collected were evaluated to determine how habitat changes with stream flow. This analysis is based primarily on changes in top-width and width to depth ratio, with changes in depth and velocity considered secondarily. Top width is evaluated as a measure of habitat quantity, while width to depth ratio, depth and velocity are measures of habitat quality.

Generally, the greater the top width, the greater the amount of habitat. Changes in top width were considered from the standpoint of the absolute and relative change in top width from one flow to the next. Large changes in top-width would indicate a large change in the amount of potential living space available to steelhead. While top width is not the same as suitable habitat, it has been used as an index of the amount of habitat available in the past (Swift 1976, Annear and Condor 1983, Nelson 1984). While top width can be used as an index of habitat quantity, it does not address habitat quality. For instance, a section of stream that is 100 feet wide and 2 inches deep provides less habitat for fish than a channel that is 20 feet wide and 2 feet deep. To address the issue of habitat quality, we have incorporated an evaluation of width to depth ratios into our analysis.

Width to depth ratios were calculated by habitat type for each reach. Generally speaking, a higher width to depth ratio denotes better habitat, as this indicates a generally narrower and deeper channel which provides the fish with more cover. At flows where there is an inflection in the width to depth ratio versus flow function, one would expect to find morphological changes in the river that might result in substantial changes in the habitat flow relationship and thus might result in substantial changes in habitat over a relatively small change in flow.

Different habitat typing systems were used between the DWR IFIM data for the Highway 154 reach and the empirical data gathered at the Refugio and Alisal Reaches. While riffles, runs, and pools were similar, the IFIM transects included shallow pools (less than 3 feet deep) and the empirical transects included glides. Comparison of velocities and depths and their response to changes in flows indicates that glide and shallow pool habitats are hydrologically similar, although the shallow pools modeled by DWR were substantially wider than the glides evaluated in the current study. The similarities in their hydrologic response indicates that they may represent the same habitat type, however the difference in width suggests otherwise. The river has experienced several high flow years between the two studies (1986 and 1996) and may have become more incised as a result of these events.

Riffles tended to be broad and shallow, as were glides and shallow pools. Runs and deep pools were narrower and deeper than riffles and glides and shallow pools. Riffle habitats had the highest velocities, runs had somewhat lower velocities, and glide/shallow pools and deep pools had relatively low velocities which were of similar magnitude at any given flow.

3.1 TOP WIDTH

Top width increased most rapidly with flow between 1.5 and 5 cfs for all habitat types and in all reaches. The top width of riffles tended to increase the most as flow increased, pools had the least change in top width with flow (Table 3-1). Generally speaking, once flow increased beyond 10 cfs, there were only minor changes in top width of all habitat types at each sequential simulated flow. This was true in terms of both the absolute magnitude of the change and the percent increase.

Table 3-1. Top Width by Habitat Type in the Three Study Reaches

Highway 154

Discharge (cfs)	Top Width (ft) Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	54	49	Not	145	64
3	58	58	Sampled	147	68
5	66	69		150	69
10	69	70		155	71
15	71	75		159	73
20	74	77		162	74
25	76	78		164	75
30	78	79		166	75
35	79	80		167	75
40	80	80		169	76
45	82	81		170	76
50	83	81		171	76

Refugio Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	41	25	51	29	52
3	44	27	54	30	53
5	46	28	56	32	54
10	51	30	59	34	55
15	53	32	61	36	56
20	56	33	62	37	57
25	57	33	64	37	57
30	59	34	65	38	57
35	60	35	65	39	58
40	61	36	66	39	58
45	62	36	67	40	58
50	63	37	68	40	58

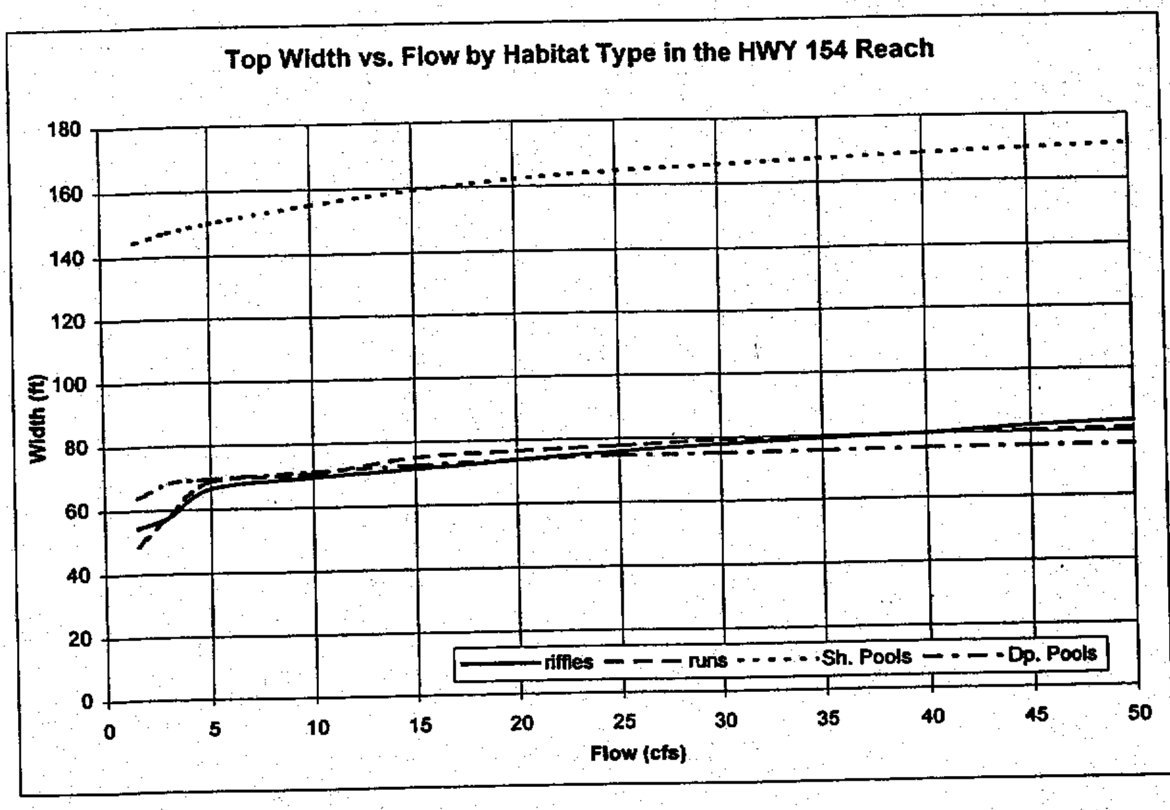
Alisal Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	33	25	42	Not	29
3	37	26	45	Sampled	31
5	40	28	47		33
10	45	30	52		37
15	48	31	54		39
20	50	32	56		41
25	52	32	58		42
30	54	33	59		44
35	55	33	61		45
40	57	34	62		46
45	58	34	63		48
50	59	35	64		49

In the Highway 154 reach, the greatest change in top width occurred when flow increased from 1.5 to 5 cfs (Figure 3-1a). This change in flow resulted in a change in top width of 9 to 10 feet in run and riffle habitats (Table 3-2a), or a relative change of nearly 20 and 15 percent, respectively (Table 3-2b). The top width of shallow pools changed the most as flows increased from 5 to 10 cfs (5 feet, 3 percent), while the top width of deep pools changed the most as flows went from 1.5 to 3 cfs (5 feet, 7 percent). As flows increased beyond 15 cfs, the relative change in the top width of all habitats was generally less than 3 feet (3 percent) between subsequent flow intervals. Top width increased by between 8 and 25 feet (11 and 45 percent), as flow was increased from 3 to 50 cfs, a 16-fold increase in flow. This increase was least in deep pools, which likely provide the best habitat for steelhead. Riffles and runs had the greatest cumulative increase in habitat.

In the Refugio Reach, the absolute change in top width from one flow value to the next exceed 4 feet only for riffle habitats as flow changed from 5 and 10 cfs (Figure 3-2a). This flow interval had the greatest change in top width for all habitats with changes ranging from 1.6 to 4.3 feet (Table 3-2c), or 3 to 9 percent (Table 3-2d). As flow increased above 15 cfs, the relative increase in top width between subsequent flow intervals was generally less than 2 feet (4 percent) for all habitat types, with the relative change diminishing with increasing flow (Table 3-2d). The cumulative percent change in top width as flow increased from 3 to 50 cfs ranged from 5 feet (8 percent) in deep pools to 19 feet (43 percent) in riffles (Figure 3-2b).

In the Alisal Reach, top widths were less than in the Refugio Reach for all habitat types except runs (Figure 3-3a). The absolute magnitude of change in top width from one flow to the next is very similar to that for the Refugio Reach, with the greatest changes occurring between 5 and 10 cfs for all habitat types (Table 3-2e). At this flow, top widths changed by between 2 and 5 feet depending on habitat. Because the top widths were generally less than in the Refugio Reach, however, the relative change in top width was somewhat higher, with all habitat types except runs having relative changes in top width of 7 to 12 percent (Table 3-2f) as flow increased from 5 to 10 cfs. As in the other two



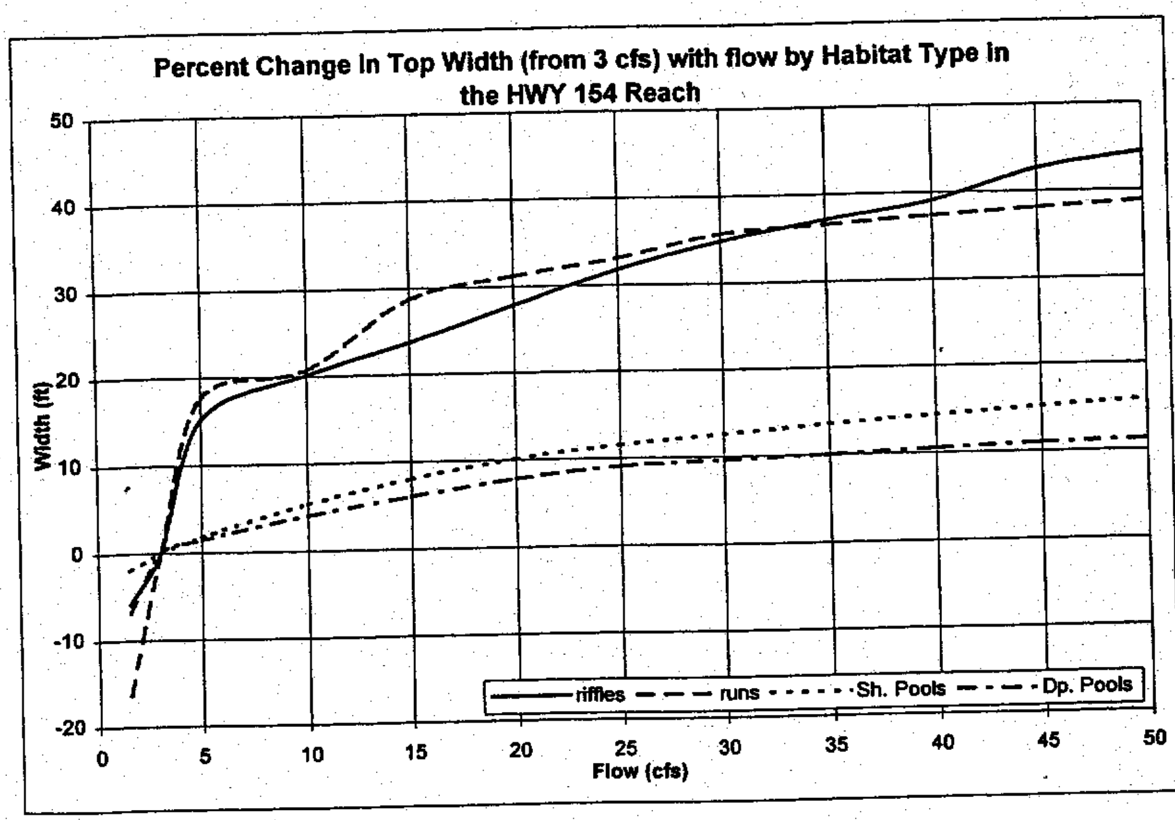


Figure 3-1. Top Width Versus Flow Relationship in the Highway 154 Reach.

Table 3-2. Change in Top Width in Each Reach.

HWY 154

a)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	not	-	-
3	3.4	9.6	sampled	2.9	4.7
5	8.7	10.3		2.7	1.0
10	2.9	1.8		5.2	1.8
15	2.1	4.6		3.9	1.3
20	2.4	1.5		3.1	1.3
25	2.3	1.1		2.0	0.9
30	1.8	1.5		1.6	0.3
35	1.3	0.5		1.4	0.3
40	1.2	0.5		1.2	0.4
45	2.1	0.4		1.2	0.3
50	1.1	0.4		1.1	0.2

b)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	not	-	-
3	6.3	19.6	sampled	2.0	7.4
5	15.1	17.6		1.8	1.5
10	4.4	2.6		3.5	2.5
15	3.0	6.6		2.5	1.9
20	3.4	2.0		1.9	1.7
25	3.1	1.4		1.2	1.2
30	2.4	2.0		1.0	0.5
35	1.7	0.6		0.8	0.4
40	1.5	0.6		0.7	0.5
45	2.6	0.5		0.7	0.4
50	1.3	0.5		0.6	0.3

Refugio

c)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	-	-	-
3	3.0	2.0	3.0	1.9	1.2
5	2.5	1.0	1.9	1.5	0.9
10	4.3	2.1	3.0	2.2	1.3
15	2.8	1.4	1.9	1.4	0.8
20	2.1	1.1	1.5	1.0	0.6
25	1.7	0.9	1.2	0.8	0.5
30	1.4	0.8	1.0	0.7	0.4
35	1.3	0.7	0.9	0.6	0.3
40	1.1	0.6	0.8	0.5	0.3
45	1.0	0.5	0.7	0.5	0.2
50	0.9	0.5	0.6	0.4	0.2

d)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	-	-	-
3	7.3	8.0	5.9	6.6	2.3
5	5.6	3.6	3.5	4.9	1.7
10	9.2	7.6	5.4	6.9	2.4
15	5.4	4.7	3.3	4.1	1.4
20	3.9	3.4	2.4	2.9	1.0
25	3.0	2.7	1.9	2.3	0.8
30	2.5	2.3	1.6	1.9	0.7
35	2.1	2.0	1.3	1.6	0.6
40	1.9	1.7	1.2	1.4	0.5
45	1.7	1.5	1.1	1.2	0.4
50	1.5	1.4	0.9	1.1	0.4

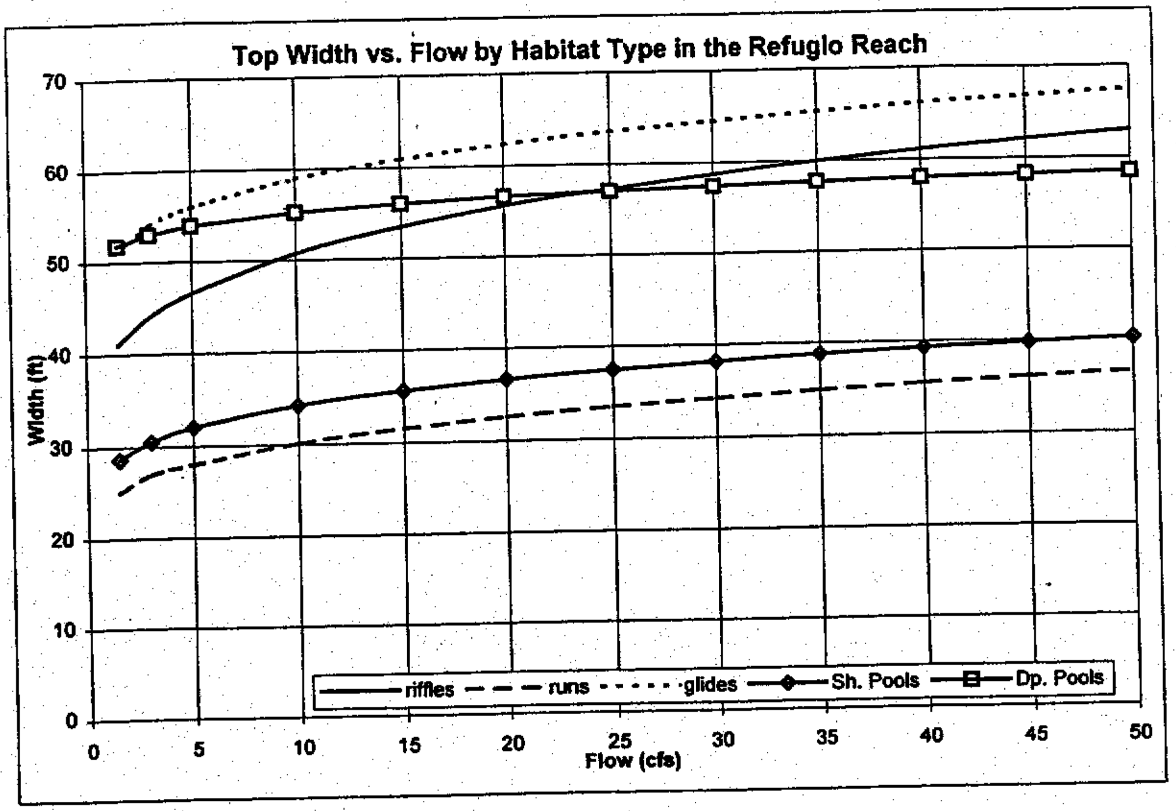
Alisal

e)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	-	not	-
3	4.0	1.0	3.0	sampled	2.0
5	3.2	1.7	2.5		2.4
10	4.8	1.9	4.1		3.2
15	3.1	1.2	2.7		2.3
20	2.4	0.9	2.0		1.9
25	1.9	0.7	1.7		1.6
30	1.6	0.6	1.4		1.5
35	1.4	0.5	1.2		1.3
40	1.3	0.4	1.1		1.2
45	1.2	0.4	1.0		1.2
50	1.1	0.4	0.9		1.1

f)

Discharge	riffles	runs	glides	sh. pools	dp. pools
1.5	-	-	-	not	-
3	12.1	4.0	7.1	sampled	6.9
5	8.6	6.7	5.5		7.6
10	11.9	6.8	8.7		9.7
15	6.9	4.0	5.2		6.3
20	4.9	2.8	3.8		4.8
25	3.8	2.2	3.0		4.0
30	3.1	1.8	2.5		3.4
35	2.6	1.5	2.1		3.0
40	2.3	1.3	1.8		2.7
45	2.0	1.2	1.6		2.5
50	1.8	1.1	1.5		2.3



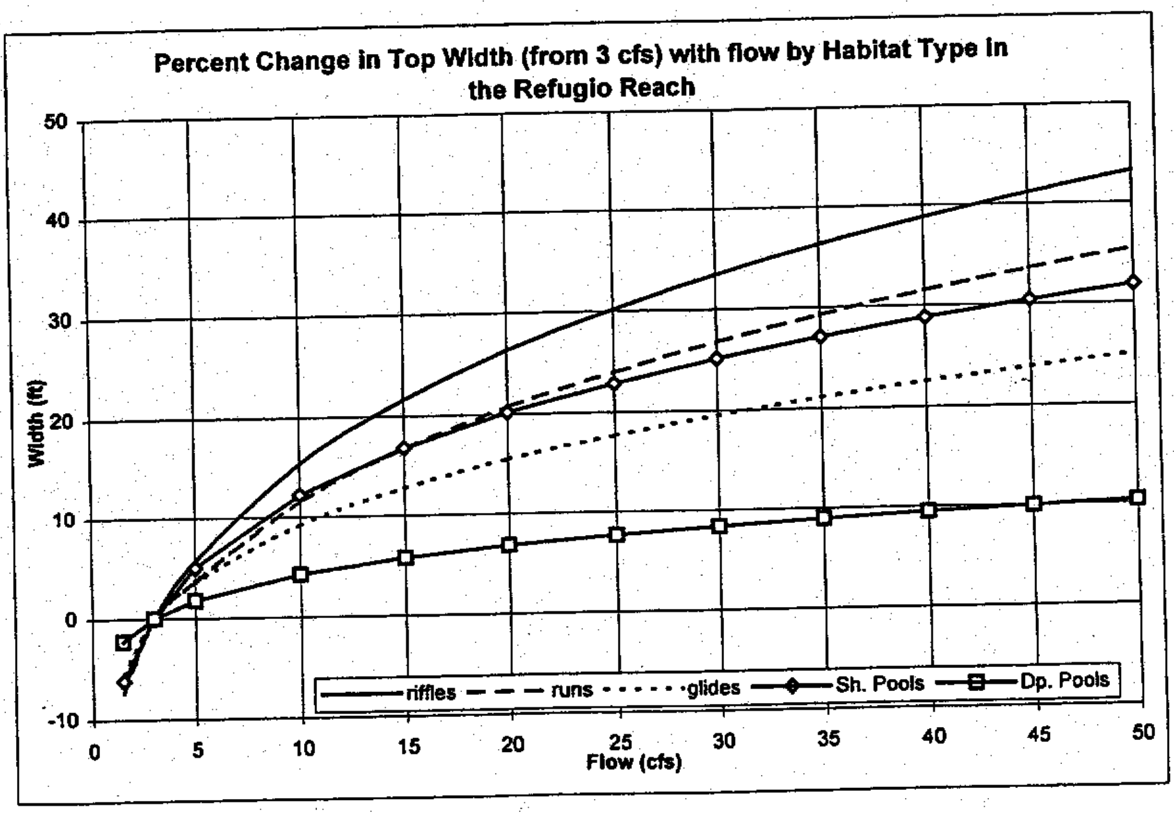
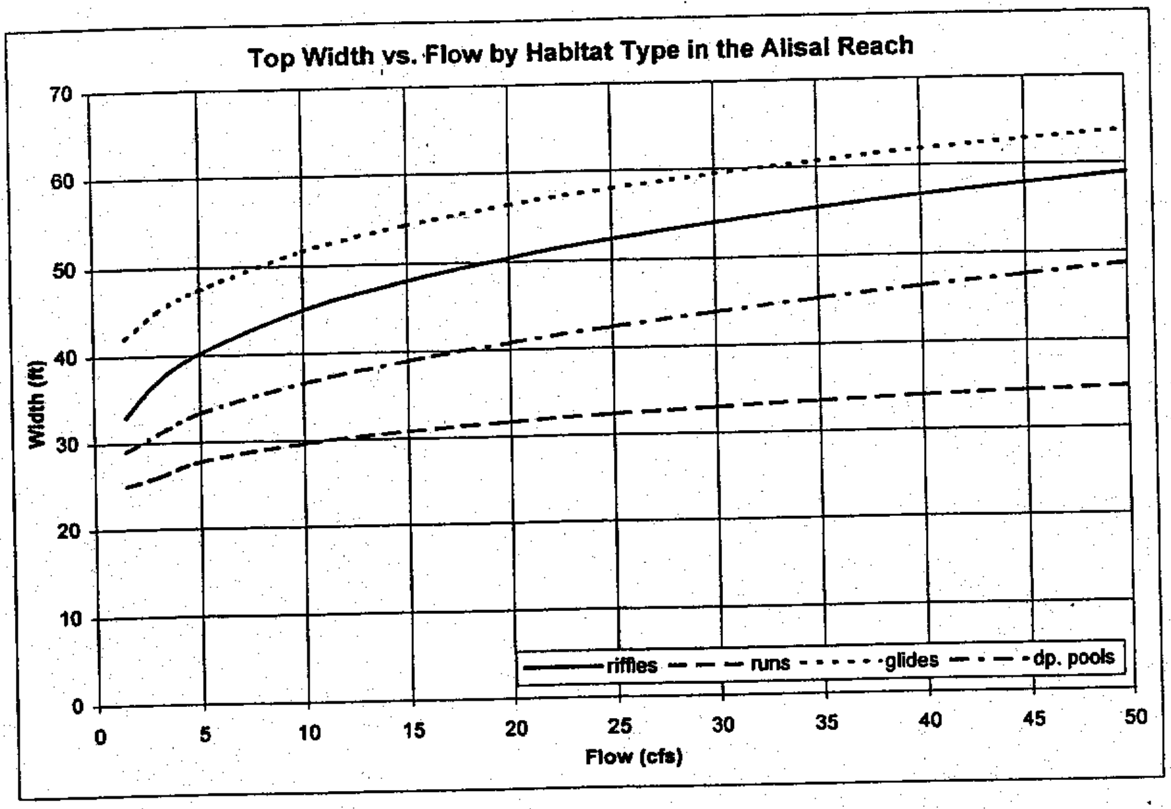


Figure 3-2. Top Width Versus Flow Relationship in the Refugio Reach.



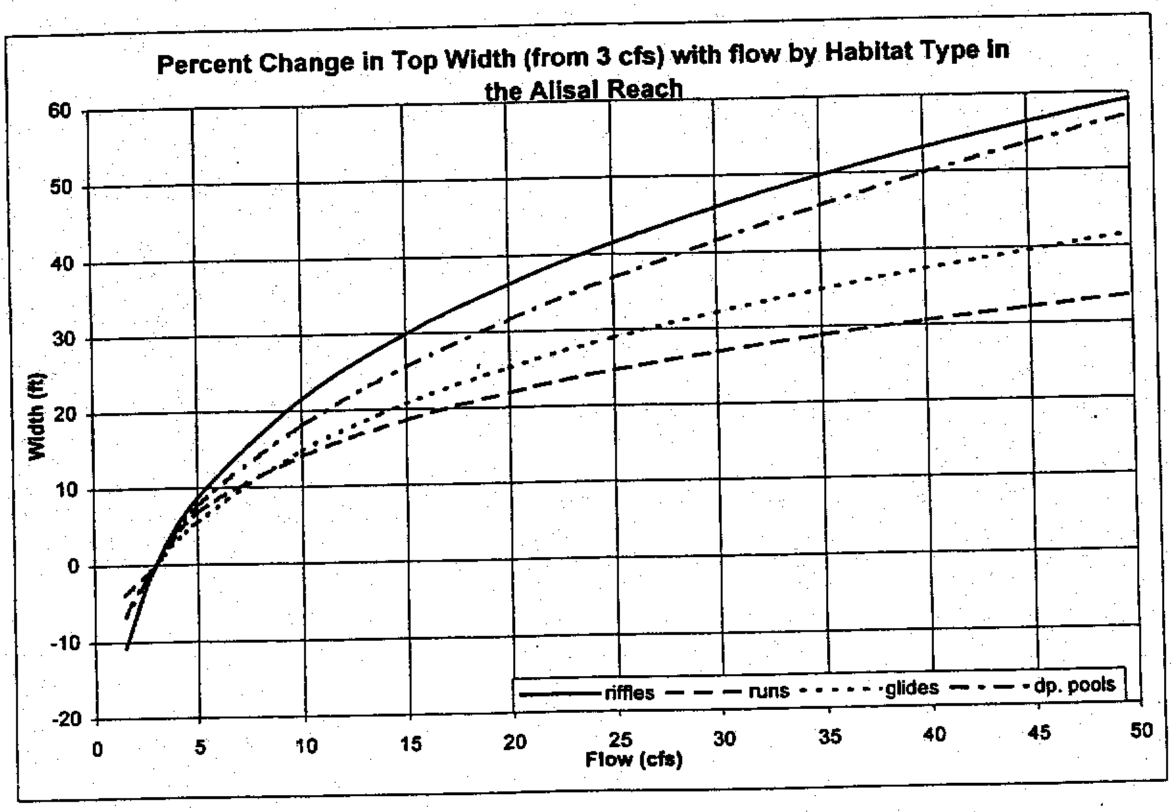


Figure 3-3. Top Width Versus Flow Relationship at the Alisal Reach.

reaches, the relative change in top width decreases with increasing flow, generally increasing less than 3 feet (5 percent) between simulation flows as flow increased beyond 15 cfs. The cumulative change in top width ranged from 9 to 22 feet (34 to 58 percent) as flow increased from 3 to 50 cfs. Unlike the other two reaches, deep pools in the Alisal Reach had the second highest proportional increase in top width, rather than the lowest increase.

In general, deep pools had the least change in top width in response to changing flows, while riffles had the most change. In the Alisal Reach, however, deep pools changed more than did glides or runs. In all reaches, the amount of increased flow needed to obtain a given increase in top width is proportionately much greater than the amount of habitat gained. For example, to increase glide top widths by 10 percent in the Refugio Reach requires more than a 300 percent increase in flow. To attain a similar increase in deep pool habitats in the Highway 154 Reach requires an increase in flow of nearly 1,300 percent. The habitats in the Alisal Reach are more responsive than in the other reaches, requiring about a 200 to 250 percent change in flow to obtain a 10 percent change in top width for all habitat types.

3.2 WIDTH TO DEPTH RATIOS

The width to depth ratios were fairly uniform across the range of flows modeled in all habitat types except riffles (Figure 3-4). The width to depth ratio in riffles was generally much higher than that of the other habitat types and decreased as flow increased. The rate of change in the width to depth ratios in riffles at the Refugio and Alisal reaches changed substantially at about 5 cfs. Glides in the Refugio Reach and shallow pools in the other reaches also had higher width to depth ratios than runs and deep pools. In the Highway 154 Reach, the width to depth ratios of shallow pools was greater than that of riffles at all flows and generally declined as flow increased. The declining width to depth ratio here and in the riffle habitats in all reaches indicates that the proportional increase in width is less than the proportional increase in depth as flow increases. This indicates that in these shallow habitat types, you generally improve habitat as you increase flow, and that this improvement is greatest as flows increase between 1.5 and 5 cfs in the Refugio

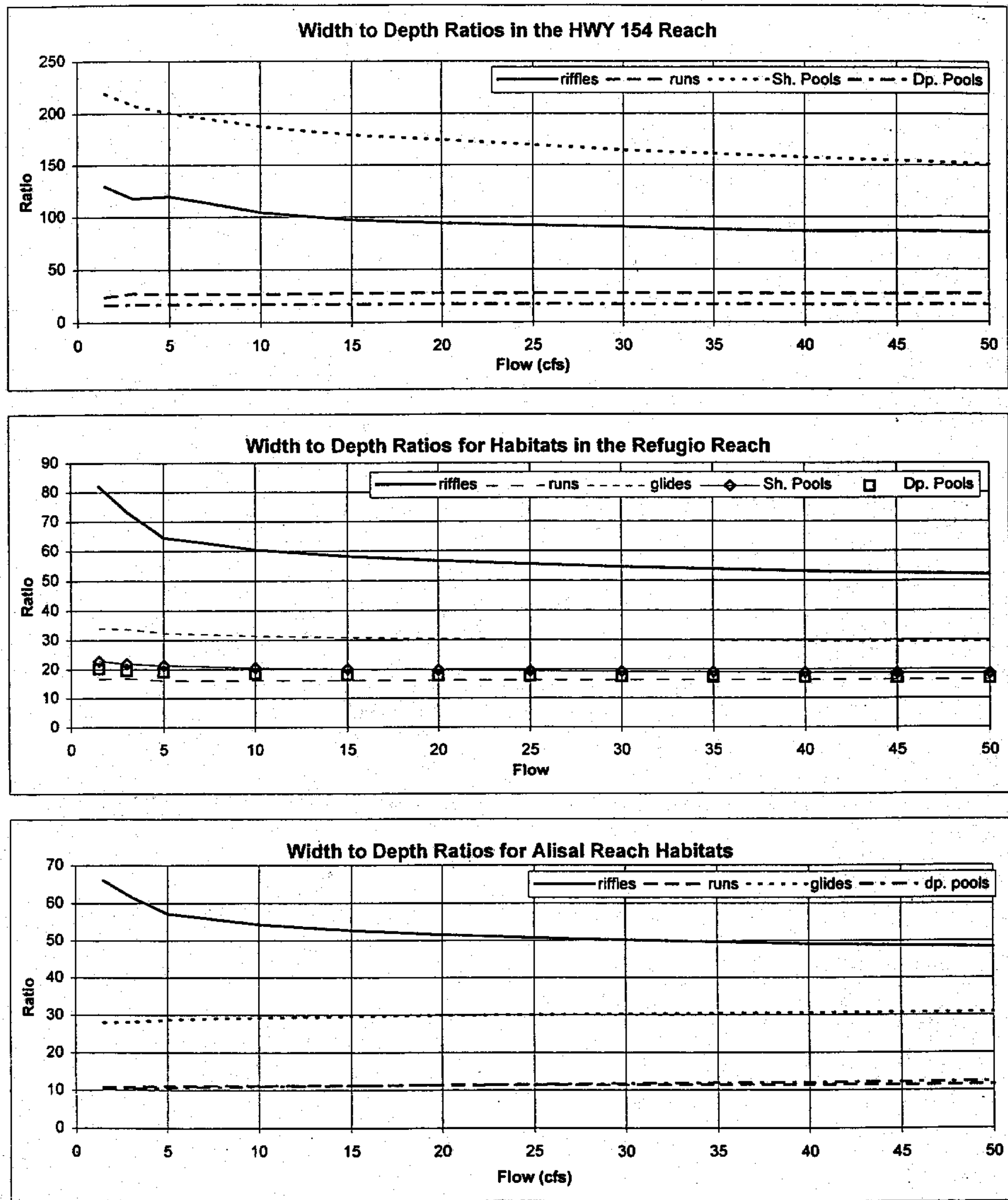


Figure 3-4. Width to Depth Ratio by Reach and Habitat Type.

and Alisal reaches. In the Highway 154 Reach, the inflection in the width to depth ratio is not as pronounced for the riffle or the shallow pool habitats, but appears to lie between 10 and 15 cfs.

The relatively constant width to depth ratios in the other habitat types indicates that there is not a substantial change in habitat as flow increases. Based on this, it is reasonable to use the results of the top width analysis to assess changes in habitat with flow in these habitats.

3.3 MAXIMUM DEPTH

As would be expected, the values of maximum depth increased with flow in all reaches and in all habitat types (Table 3-3, Figure 3-5). Unexpectedly, deep pools showed an initially greater response to changes in flow in the Refugio (Figure 3-5b) and Alisal reaches (Figure 3-5c) than did the other habitat types. This greater change in maximum depth is attributed to the narrower channel widths of deep pools and their inability to increase velocities as rapidly as other habitat types, because of their downstream controls. However, over the entire range of flows simulated, deep pools had the lowest response of any habitat type. Across habitats, the Refugio Reach had the greatest average change in depth (0.8 feet), and the Highway 154 Reach had the least (0.6 feet). Generally, depths increased relatively slowly over the range of simulated flows in all reaches and in all habitats. The changes in depth at flows of 1.5 versus 50 cfs ranged from 0.4 to 1.1 feet. This 3,200 percent increase in flow resulted in an increase of depth ranging from 15 to 250 percent.

3.4 VELOCITY AT THE THALWEG

Velocity at the thalweg increased as a function of flow in all habitat types and in all reaches. Riffles had the greatest increase in velocity with increased flow, followed by runs, and then by shallow pools and glides (Table 3-4, Figure 3-6). Deep pools had the lowest increase in velocity with increased flow levels. The velocity in riffles at 5 cfs was 0.4 to 0.5 fps and increased to 1.3 to 1.8 fps at 50 cfs. In deep pools, velocities were 0.0 to 0.1 fps at 5 cfs and 0.3 to 0.7 fps at 50 cfs, depending on the reach.

Table 3-3. Thalweg Depth by Habitat Type in the Three Study Reaches

Highway 154

Discharge (cfs)	Maximum Depth (ft)				
	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.4	2.1	Not	0.7	4.0
3	0.5	2.1	Sampled	0.7	4.1
5	0.6	2.5		0.8	4.1
10	0.7	2.7		0.8	4.2
15	0.7	2.7		0.9	4.3
20	0.8	2.8		0.9	4.4
25	0.8	2.9		1.0	4.4
30	0.9	2.9		1.0	4.5
35	0.9	2.9		1.0	4.5
40	0.9	3.0		1.1	4.6
45	1.0	3.0		1.1	4.6
50	1.0	3.0		1.1	4.6

Refugio Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.5	1.5	1.5	1.3	2.6
3	0.6	1.6	1.6	1.4	2.7
5	0.7	1.7	1.7	1.5	2.8
10	0.8	1.9	1.9	1.7	3.0
15	0.9	2.0	2.0	1.8	3.1
20	1.0	2.0	2.1	1.9	3.2
25	1.0	2.1	2.1	1.9	3.3
30	1.1	2.1	2.2	2.0	3.3
35	1.1	2.1	2.2	2.0	3.4
40	1.1	2.2	2.2	2.1	3.4
45	1.2	2.2	2.3	2.1	3.4
50	1.2	2.2	2.3	2.2	3.5

Alisal Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.5	2.3	1.5	Not	2.8
3	0.6	2.4	1.6	Sampled	3.0
5	0.7	2.5	1.7		3.1
10	0.8	2.6	1.8		3.3
15	0.9	2.7	1.8		3.5
20	1.0	2.8	1.9		3.6
25	1.0	2.9	1.9		3.7
30	1.1	2.9	2.0		3.7
35	1.1	2.9	2.0		3.8
40	1.2	3.0	2.0		3.8
45	1.2	3.0	2.0		3.9
50	1.2	3.0	2.1		3.9

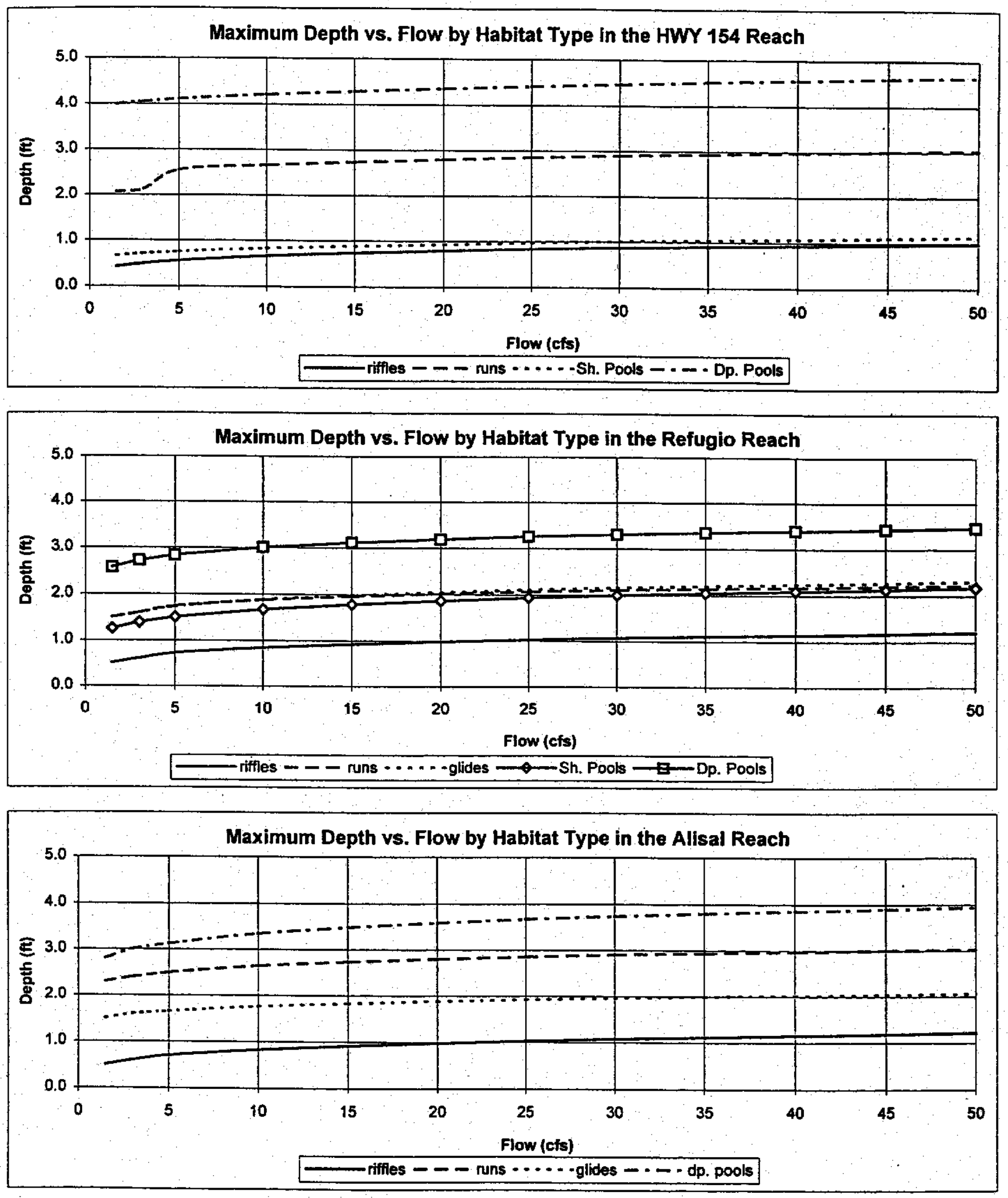


Figure 3-5. Depth Versus Flow Relationship by Reach and Habitat Type.

Table 3-4. Thalweg Velocity by Habitat Type in the Three Study Reaches.

Highway 154

Discharge (cfs)	Thalweg Velocity (fps) Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.3	0.1	Not	0.0	0.0
3	0.4	0.1	Sampled	0.1	0.0
5	0.4	0.2		0.1	0.0
10	0.6	0.3		0.2	0.1
15	0.8	0.4		0.2	0.1
20	0.9	0.5		0.3	0.1
25	1.1	0.5		0.3	0.2
30	1.2	0.6		0.4	0.2
35	1.3	0.7		0.4	0.2
40	1.4	0.7		0.5	0.2
45	1.5	0.8		0.5	0.3
50	1.6	0.9		0.5	0.3

Refugio Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.3	0.1	0.1	0.1	0.0
3	0.4	0.2	0.1	0.1	0.1
5	0.5	0.3	0.1	0.2	0.1
10	0.6	0.4	0.2	0.3	0.1
15	0.9	0.5	0.3	0.4	0.2
20	1.0	0.6	0.3	0.5	0.3
25	1.2	0.8	0.4	0.5	0.3
30	1.3	0.9	0.4	0.6	0.4
35	1.4	1.0	0.5	0.7	0.5
40	1.5	1.1	0.6	0.7	0.5
45	1.6	1.2	0.6	0.8	0.6
50	1.8	1.3	0.7	0.9	0.7

Alisal Reach

Discharge (cfs)	Riffle	Run	Glide	Sh. Pools	Dp. Pools
1.5	0.3	0.0	0.1	Not	0.1
3	0.3	0.1	0.2	Sampled	0.1
5	0.4	0.1	0.2		0.1
10	0.6	0.2	0.3		0.2
15	0.7	0.3	0.4		0.3
20	0.8	0.4	0.5		0.3
25	0.9	0.5	0.5		0.4
30	1.0	0.6	0.6		0.4
35	1.1	0.7	0.6		0.5
40	1.2	0.8	0.7		0.5
45	1.2	0.9	0.7		0.6
50	1.3	1.0	0.8		0.6

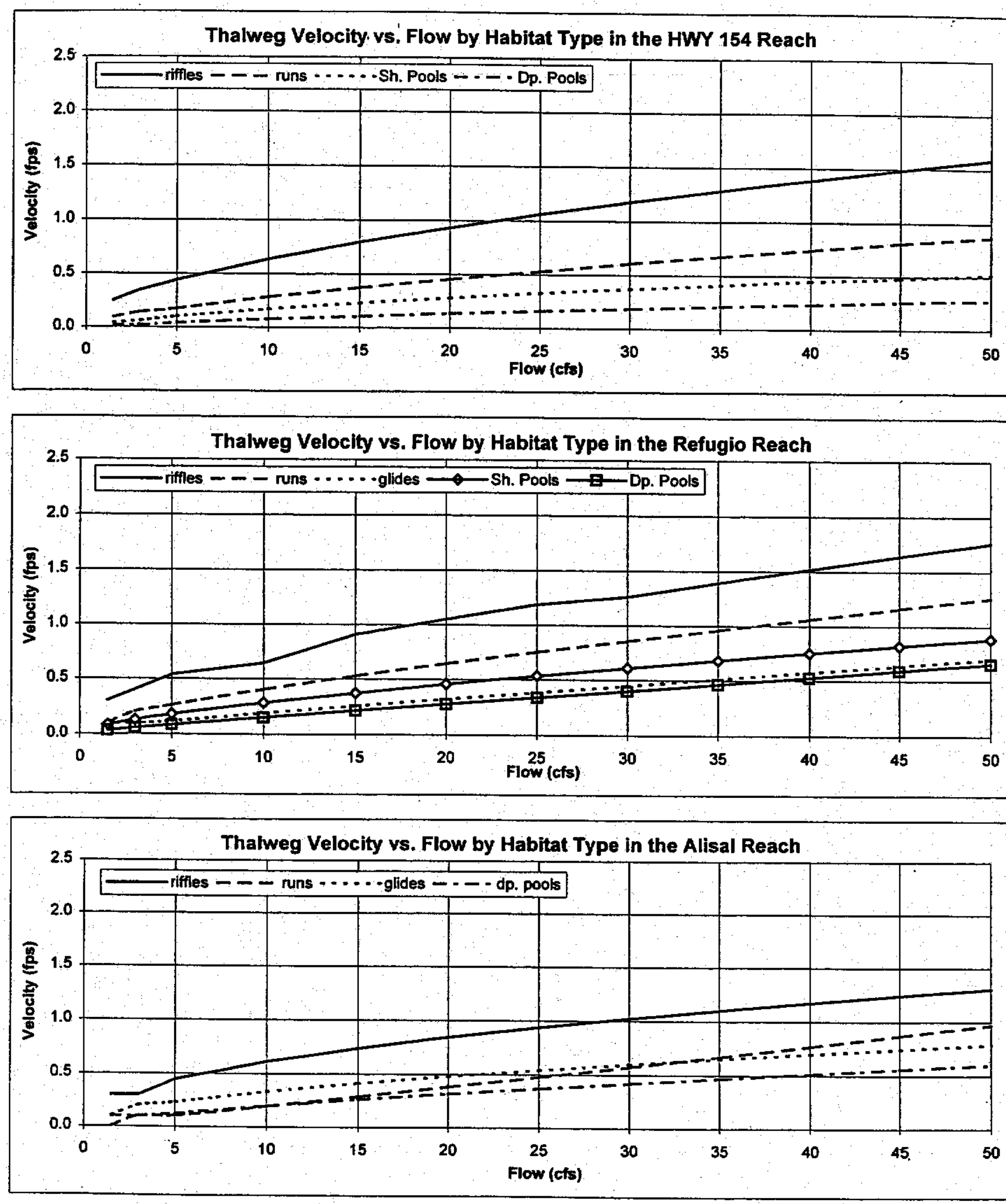


Figure 3-6. Velocity Versus Flow Relationship by Reach and Habitat Type.

[To be discussed with DFG]

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