Status and Trends of Fish Habitat Condition on Private Timberlands in Southeast Alaska: 2009 Summary

Douglas Martin

Martin Environmental

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Final Report

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Prepared for:

Sealaska Corporation

and

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Prepared by:

Douglas J. Martin
Martin Environmental
2103 N 62nd Street
Seattle, Washington 98103

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The effectiveness of the Forest Resources and Practices Act (FRPA) to protect water quality and fish habitat is a region wide concern for Southeast Alaska. The revised FRPA (1990) included a wide range of best management practices (BMP) that were intended to protect riparian ecological process (e.g., shade, large woody debris, bank stability), fish habitat, and water quality. The FRPA recommended that the new BMPs be evaluated through research and monitoring, and be subject to review by the Board of Forestry in collaboration with the Alaska Departments of Environmental Conservation (DEC), the deputy commissioner, other affected agencies, and the forest dependent industries. To address FRPA needs, Sealaska initiated a riparian BMP effectiveness monitoring program in the early 1990's that documented aquatic habitat conditions from 1994 through 1998. In 2003, Sealaska began working in collaboration with the Alaska Department of Natural Resources and DEC through the Alaska Clean Water Action Grant program to expand the geographic coverage and to facilitate long-term trend monitoring on private timberlands in Southeast Alaska. Data were collected at previously surveyed reaches and at new reaches that were added for status and trend monitoring. In 2009 we repeated data collection at selected old and new trend monitoring study reaches to maintain the status and trend monitoring program. This report presents the data that were collected during the 2009 field season and presents selected results from the trend monitoring database. A schedule for trend monitoring and discussion of monitoring needs in future years is included.

1.0 BACKGROUND AND OBJECTIVES

The Alaska Forest Resources and Practices Act (Act) was amended in 1990, and the revised Forest Resources and Practices Regulations (Regulations) were adopted in 1993 (Alaska Department of Natural Resources [ADNR] 2000, 2003). The Act required that riparian buffer zones be retained along all streams with anadromous fish for the protection of fish habitat and water quality. The Regulations specified that resource management agencies and forest landowners were to conduct monitoring to evaluate the effectiveness of best management practices (BMPs) to protect public resources.

In 1992 Sealaska Corporation and the Alaska Forest Association initiated a monitoring program to examine the effectiveness of riparian buffer zones on private timberlands to protect fish habitat. This program included monitoring studies between 1992 and 1997 that addressed riparian stand composition, channel morphology, fish habitat, large woody debris (LWD), stream shading, spawning gravel sedimentation, mass wasting, and sediment supply (Martin 1994, 1995, 1996; Martin et al. 1996, 1997, 1998; Perkins 1999). During 1998 to 2001, the program expanded cooperators with the addition of the Alaska Departments of Environmental Conservation and Natural Resources through the Community Water Quality Grant program. The research shifted from routine monitoring of fish habitat conditions to studies of windthrow effects on LWD supply in buffer zones and LWD recruitment and transport mechanisms in streams (Martin 2001; Martin and Benda 2000, 2001; Martin and Grotefendt 2001, 2005, 2007). These studies established a large network of buffer zone monitoring sites and contributed new information that improved our knowledge and understanding of buffer zone characteristics, LWD recruitment, and the fate of LWD in streams.

In 2003 the fish habitat and channel conditions monitoring program was resumed by the Sealaska Corporation in collaboration with the ADNR through the Alaska Clean Water Action Grant program (Martin 2009, Martin and Shelly 2004, 2005, 2006, 2007, 2008). Data were collected at previously surveyed reaches and at new reaches that were added for status and trend monitoring. An analysis of habitat trends was performed for a subset of reaches that had multiple years of monitoring data and were suitable for trend analysis. These data were divided into two analysis groups: those with data only post-harvest and those with data pre- and post-harvest. The results of this analysis changed with each successive year of monitoring data. Following 2003, no significant trends were detected. After 2004, we found significant trends in habitat conditions were emerging for some habitat variables at both the post-harvest and pre- and post-harvest study sites. In addition, the results suggested that the full impacts of logging on habitat may not be observed initially after timber harvest; rather habitat responses are occurring over time (delayed response) and are predicted to continue into the future. The magnitude and duration of habitat response after logging are unknown at this time. Therefore, continued monitoring is needed at the existing and newly established study sites to document and examine the post-harvest response trends. A long-term strategy for trend monitoring using a pulsed sampling approach (Bryant 1995) was developed during 2005 to facilitate trend monitoring in a cost-effective manner (see Martin and Shelly 2006). We established two monitoring groups: one group of stream reaches (annual panel) that would be monitored annually and a second larger group (pulsed panel) that would be monitored on a pulsed schedule. In 2006 we shifted monitoring to the annual panel (small group) and continued this schedule through 2009.

In 2009 the objectives of the monitoring program were as follows:

1. Continue the status and trend monitoring of fish habitat conditions that was initiated by the forest industry during the 1990s.

2. Collect pre-harvest data for a subset of long-term trend monitoring study reaches to establish a baseline for future post-harvest comparison.

3. Continue data collection at a subset of existing long-term trend monitoring study reaches to maintain continuity in the long-term record.

4. Document the 2009 findings in a data report.

This report summarizes the data that were collected during the 2009 field season and presents selected results from the trend monitoring database.

2.0 STUDY AREA

In 2009 we collected data at 11 study sites that include both old and new (established in 2003-2004) trend monitoring study reaches. The survey reaches were located in three basins in the Hoonah area and four basins in the Craig area (Figure 1). Most of the reaches in both areas were MM channel type (Table 1). Eight study reaches had buffer zones with timber harvest on one or both sides of the stream as of July 2009. Buffer strip widths and lengths vary among the study reaches. Buffer strips bordered the entire lengths of the older reaches (i.e., Eagle 1, East Eagle 1, Coco 1a, 2a). At the Trocadero and Gartina-2 sites (new study reaches), the buffer strips were generally greater than 20 m wide and only occurred along portions of the survey reaches. No buffer strips and harvest units are planned for the other study reaches (Game 8, Gartina 1b, Estrella) at this time.

Table 1. Physical characteristics, timber harvest period, and survey history at 2009 study reaches.

Stream reach	Survey length (m)	Channel width (m)	Channel type[a]	Buffer zone present	Harvest period	Year first surveyed	No. of surveys
Hoonah Area							
Eagle 1	923	12.6	MM	2 sides	1992-93	1994	10
East Eagle 1	324	6.3	FP	2 sides	1992-93	1994	9
Game 8	209	4.6	MM	unlogged	none	1997	6
Gartina 1b	292	4.6	MM	unlogged	none	2003	6
Gartina 2	279	5.9	FP	1 side	2008	2003	6
Craig Area							
Coco 1a	451	7.2	MM	2 sides	2002	1994	10
Coco 2a	350	5.3	MM	2 sides	2003	1994	10
Estrella 1	530	13.4	FP	unlogged	none	1995	9
Raven 1	393	7.4	MM	2 sides	1999	1996	6
Trocadero Sec 21	375	8.1	MM	2 sides	2007-08	2004	5
Trocadero Sec 26	270	8.3	MM	2 sides	2007-08	2004	5

[a] From Paustian et al. (1992)

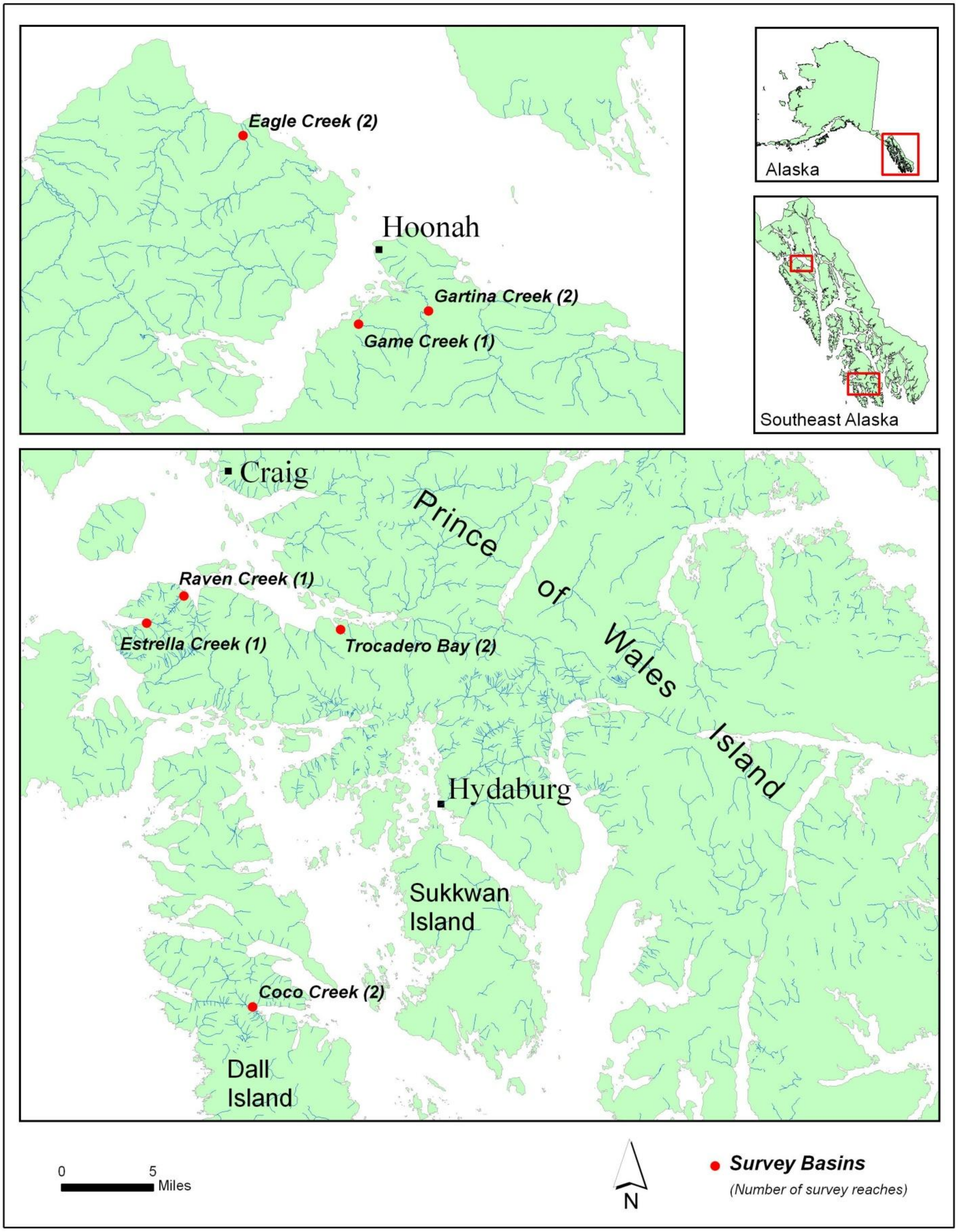


Figure 1 Location of stream basins that were surveyed during 2009. Number in parentheses denotes the number of stream reaches that were surveyed at each basin.

3.0 METHODS

3.1 FIELD SURVEY

Habitat measurements were taken from each channel unit (e.g., pools and riffles) within a stream reach. Channel units were defined by depth, velocity, and morphological characteristics similar to those described by Bisson et al. (1982). Channel units were stratified into main channel, associated unit, or off-channel categories. Units that contained the stream thalweg during summer base flow were defined as main channel units. Pools embedded within or adjacent to a main channel unit were categorized as associated units. Off-channel units included pools, ponds, or side channels that had a surface connection with the main channel and occurred within the active flood plain. Main channel and associated pools were further subdivided into primary pools and other pools based on the minimum area and minimum residual depth criteria defined by the Washington Timber-Fish-Wildlife Ambient Monitoring Program (Table 2).

Table 2 Minimum area and residual depth criteria for pools based on stream width (from Schuett-Hames et al. 1994).

Bankfull width (m)	Area (m^2)	Residual depth (m)
0 - 2.5	0.5	0.10
2.5 - 5	1.0	0.20
5 - 10	2.0	0.25
10 - 15	3.0	0.30
15 - 20	4.0	0.35
> 20	5.0	0.40

Habitat variables were computed from measurements of each channel unit. Unit length was measured along the centerline of the channel with a hip chain to the nearest 1 m, and the unit width (wetted) was measured to the nearest 0.5 m with a graduated rod at one location for fast water units and at two locations for pools. The product of unit length and mean width provided an estimate of wetted unit area. The percentage of habitat area for each primary pool type relative to the total wetted area of the reach was defined as the relative pool area (RPA). The percentage of the study reach length with primary pool habitat was defined as the relative pool length (RPL). Pool frequency was computed by dividing the number of pools in a reach by the reach length and standardized to 100 m. Pool spacing was computed by dividing the reach length, expressed in units of bankfull channel width, by the number of primary pools (including associated units) in the main channel portion of a reach. The number of channel widths in a reach was equal to the reach length divided by the mean channel width.

The tail crest and maximum depths of pools were measured with a graduated rod to the nearest 1.0 cm. The residual depth of pools (Lisle 1987) was computed from the difference between the maximum depth and the tail crest depth.

All LWD occurring either in the bankfull influence zone of the active channel (i.e., Zones 1 and 2 of Robison and Beschta 1990) or above the active channel (Zone 3 of Robison and Beschta 1990) was measured. LWD was defined as any piece of wood that was a minimum 0.1 m in diameter at the small end of the log and a minimum 2 m long. Each piece was assigned to a size group based on the estimated diameter at the center of the log: small (10-30 cm), medium (30-60 cm), and large (> 60 cm). A graduate rod was used to calibrate ocular estimates of log diameter. During the 1998 and 2003 to 2009 surveys, the length of each piece was measured to the nearest 3-m interval; no length data were collected from earlier surveys. Piece volume was computed from piece length and diameter data using the geometry for a cylinder.

LWD was assigned to one of two location categories: pieces in jams or pieces located between jams. Jams were defined as LWD accumulations (two or more pieces) that block at least 20% of the bankfull channel width. Jam length (length of channel cover by a jam) and the length of interjam zones were measured with a hip chain.

LWD pieces that could be linked to their riparian location or source of recruitment were defined as recruits (i.e., recruits are a subset of LWD data). Recruits are pieces (usually whole trees) that are clearly attached to the adjacent bank (e.g., rooted to bank or trunk extending into riparian forest) or are contained in a slump/bank-slide deposit. All recruits were assigned a decay class using a modified version of a snag classification system by Hennon et al. (2002). Decay class was determined for the portion of a log that was on the bank or was least disturbed by stream flow. Decay classes were as follows: "green" (green leaves or needles retained), "twig" (twigs retained), "branch" (secondary branches retained), "primary" (only primary branches and some nubs retained), "nubs" (no branches and only nubs retained, and "old" (all advanced decay conditions including soft rotten and moss covered logs with dependent saplings growing on the bole). The green decay class included a small number of live trees where the bole was down in the channel and functioning as LWD.

Bankfull channel width (referred to as channel width) and substrate size composition measurements were taken at three to seven stations located at riffle units within each survey reach. Channel width was defined by topographic breaks along the bank and by scour lines along the active channel edge where perennial vegetation gave way to mineral substrate on the streambed (Harrelson et al. 1994). Channel widths were measured to the nearest 0.1 m at established cross-sections (marked with stakes) on riffles in straight and uniform sections of the reach that were mostly free of hydraulic obstructions (e.g., over time new trees recruited to the channel may form obstructions in the survey riffle). A pebble count (Wolman 1954) of 100 particles was taken on the riffle at each cross-section location to determine the bed material size composition. Bed material measurements were taken at one-step intervals along cross-channel traverses directly adjacent to (i.e., upstream and downstream of) the cross-section location. The d_{16} and d_{50} particle sizes were interpolated from a cumulative frequency distribution of the pebble size data as per Harrelson et al. (1994).

Photos were taken during each survey at each pebble count/channel width station to document channel position, bed and bank composition, channel disturbances, and LWD patterns.

3.2 ANALYSIS

We plotted the 2009 data with previous data for selected habitat variables to display general trends and patterns to or changes in the variables over time. The data were sorted into three groups; sites with no logging or only helicopter harvest, sites with pre- and post-harvest data, and sites with only post-harvest data. No statistical analyses were performed at this time.

4.0 SUMMARY OF 2008 DATA

Summaries of LWD recruitment, LWD loading, pool characteristics, and substrate particle size are presented in Tables 3 through 7. All raw data are contained on a compact disc that was submitted under separate cover to the Alaska Department of Environmental Conservation.

The recruitment of new LWD (i.e., green recruits) was observed at eight of the eleven monitoring reaches (Table 3). New recruitment occurred at both logged and unlogged reaches, and the highest rate occurred at Trocadero Sec 26, which was recently logged (2007). Recruitment rates for the green decay class (new recruits) is generally low (e.g., < 2 pieces/100 m) at the unlogged/helicopter sites and at the long-term post-harvest monitoring sites. Higher recruitment rates, ranging from 3 to 10 pieces/100m, were observed at four of the nine pre- post-harvest monitoring sites (Figure 2).

LWD loading densities and volume were highly variable among the study reaches (Table 4). The lowest (23 pieces/100 m) and highest (79 pieces/100 m) LWD loadings were observed at two unlogged sites (i.e., Gartina 1b and Estrella 1), and loadings at the logged reaches varied within this range. The trends in LWD densities at the unlogged reaches are variable; some increasing and some unchanged over time. However, LWD densities are generally increasing after logging at the pre- post-harvest sites and at the post-harvest sites (Figure 3). Large increases in LWD density were observed at both Trocadero reaches in the past two years since logging. Densities have also increased at Estrella during the same time period even though no logging has occurred near this study reach.

Jam frequency also varied several fold among the study reaches. The highest jam frequency was observed at Game 8, which has a small channel, and the lowest frequency occurred at Eagle 1, which has a large channel (Table 5). The inverse relationship between jam frequency and channel width is consistent with other data that we have collected (Martin and Benda 2001) and reflects the wood transporting potential of larger streams. Spacing between jams declines in the smaller streams, making it difficult to discern where one jam ends and another jam begins. Difficulties in delineating jam boundaries can affect the accuracy of determining jam frequency for smaller streams.

Pool frequency ranged from 2.1 to 6.5 pools/100 m, and RPA ranged from 18% to 68% (Table 6). Trends in pool frequency at the unlogged sites are variable (i.e., no consistent pattern among sites over time; Figure 4). Pool frequency has declined at both Trocadero reaches after logging, but this response is not evident at the other pre- post-harvest sites (Figure 4). At the post-harvest sites pool frequency continues to increase over the long term at most of the study reaches.

Streambed substrate surveys were performed at all but one of the cross sections at one study reach (Table 7). Excessive windthrow covered the cross section at Coco 2a Station 1150 and inhibited the pebble count survey. Substrate was dominated by gravel (i.e., 2-64 mm) and cobble (i.e., 64-256 mm) size material at all reaches. Sand (< 2 mm) and boulder (> 256 mm) size substrate were observed but were rare. Trends in substrate d_{50} were variable at the unlogged sites

(Figure 5). Trends were relatively flat at three sites (Estrella 1a, Fisheye, and Hetta), slightly declining at two sites (Game 8 and View Cove), and increasing at one site (Gartina 1b). There is a general decline in median substrate size (d_{50}) at nearly all of the pre- post-harvest sites (Figure 6) and at the post-harvest sites (Figure 7) that were sampled during 2009.

Table 3 Number of LWD recruits, recruit rate, and percentage of recruits by decay class for each stream reach during 2009.

Stream reach	Recruits (no.) Above channel	Recruits (no.) In channel	Recruits (no.) Total	In-channel density (no/100 m)	Decay class (%) all recruits Green	Twig	Branch	Primary	Nubs	Old	Total green density (no/100 m/yr.)
Coco 1a	41	55	96	12.2	5.2	20.8	16.7	11.5	36.5	9.4	1.11
Coco 2a	61	54	115	15.4	4.3	25.2	21.7	10.4	30.4	7.8	1.43
Eagle 1	32	48	80	5.2	1.3	19.0	6.3	21.5	38.0	13.9	0.11
E Eagle 1	27	30	57	9.3	0.0	43.9	14.0	15.8	26.3	0.0	0.00
Estrella 1a	25	94	119	17.7	1.7	5.0	9.2	4.2	45.4	34.5	0.38
Game 8	15	14	29	6.7	0.0	3.6	0.0	32.1	28.6	35.7	0.00
Gartina 1b	8	10	18	3.4	0.0	5.6	5.6	11.1	72.2	5.6	0.00
Gartina 2	23	16	39	5.7	7.7	0.0	2.6	28.2	38.5	23.1	1.08
Raven 1	29	52	81	13.2	4.9	4.9	2.5	25.9	43.2	18.5	1.02
Trocadero Sec 21	45	59	104	15.7	1.9	28.8	15.4	6.7	33.7	13.5	0.53
Trocadero Sec 26	21	63	84	23.3	14.5	9.6	6.0	4.8	51.8	13.3	4.44

Table 4 LWD loading (number and volume) by stream reach during 2009.

	LWD Pieces (no.)					LWD Volume (m^3)				
Stream reach	**Above channel**	**In channel**	**Total**	**In-channel (no./100 m)**	**In-channel (%)**	**Above channel**	**In channel**	**Total**	**In-channel (m^3/100 m)**	**In-channel (%)**
Coco 1a	41	255	296	56.5	86.1	109.7	313.2	422.9	69.5	74.1
Coco 2a	61	215	276	61.4	77.9	124.9	161.4	286.3	46.1	56.4
Eagle 1	32	434	466	47.0	93.1	76.7	270.3	346.9	29.3	77.9
E Eagle 1	27	114	141	35.2	80.9	35.8	62.7	98.5	19.4	63.7
Estrella 1	25	418	443	78.9	94.4	38.3	533.3	571.6	100.6	93.3
Estrella 1b	2	60	62	66.7	96.8	1.2	44.1	45.3	49.0	97.3
Game 8	15	66	81	31.6	81.5	16.8	46.5	63.3	22.3	73.5
Gartina 1b	8	68	76	23.3	89.5	8.7	38.9	47.6	13.3	81.7
Gartina 2	23	117	140	41.9	83.6	33.0	104.1	137.1	37.3	75.9
Raven 1	29	237	266	60.3	89.1	31.4	267.6	299.0	68.1	89.5
Trocadero Sec21	45	163	208	43.5	78.4	71.0	162.4	233.3	43.3	69.6
Trocadero Sec26	21	193	214	71.5	90.2	29.0	178.3	207.3	66.0	86.0

Table 5 Number of LWD jams and jam frequency by stream reach during 2009.

Stream Reach	Number of Jams	Jam frequency (no/100 m)
Coco 1a	14	3.1
Coco 2a	12	3.4
Eagle 1	11	1.2
E Eagle 1	10	3.1
Estrella 1	12	2.3
Game 8	11	5.3
Gartina 1b	7	2.4
Gartina 2	11	3.9
Raven 1	14	3.6
Trocadero Sec21	12	3.2
Trocadero Sec26	12	4.4

Table 6 Pool statistics for all primary pools within the main channel by stream reach during 2009.

Stream reach	Number	Pool frequency (no/100 m)	Pool spacing (cw/pool)	RPA (%)	RPL (%)	Residual depth (cm)		
						Mean	Median	Maximum
Coco 1a	19	4.2	3.3	61.9	38.4	48.8	44	108
Coco 2a	11	3.1	6.0	21.2	15.7	37.5	31	63
Eagle 1	21	2.3	3.5	18.3	20.5	48.3	46	112
East Eagle 1	15	4.6	3.4	43.4	36.4	40.2	39	74
Estrella 1a	23	4.3	1.7	43.2	39.1	56.6	54	101
Game 8	11	5.3	4.1	23.8	17.2	30.6	30	39
Gartina 1b	10	3.4	6.3	29.0	28.4	34.0	33	52
Gartina 2	18	6.5	2.6	68.3	57.3	42.2	39	82
Raven 1	16	4.1	3.3	27.9	23.4	40.6	36.5	66
Trocadero Sec 21	8	2.1	5.8	19.2	15.2	40.5	34	73
Trocadero Sec 26	12	4.4	2.7	27.6	23.9	46.1	43	92

Table 7 Substrate particle size (mm) by location and stream reach during 2009.

Stream reach	Cross section no.	D_{16}	D_{50}	D_{84}
Coco 1a	47	10.8	34.4	75.8
Coco 1a	160	14.5	40.2	84.3
Coco 1a	305	11.0	34.9	83.0
Coco 2a	887	4.4	21.2	53.7
Coco 2a	950	6.3	39.4	97.3
Coco 2a	1060	16.3	67.9	174.7
Coco 2a	1150	windthrow inhibited survey		
Coco 2a	1220	14.0	45.8	146.7
Eagle 1	0	4.7	17.1	55.8
Eagle 1	170	12.2	32.0	83.7
Eagle 1	305	8.7	39.7	91.4
Eagle 1	474	16.3	35.9	88.6
Eagle 1	570	10.3	27.1	83.3
Eagle 1	715	4.4	21.2	87.3
Eagle 1	865	6.1	28.0	97.1
East Eagle 1	35	3.0	9.5	26.6
East Eagle 1	160	4.4	16.0	40.3
East Eagle 1	275	4.9	15.8	41.1
Estrella 1a	0	5.2	13.1	31.1
Estrella 1a	128	4.7	11.2	26.7
Estrella 1a	300	6.5	18.3	52.9
Estrella 1b	573	5.6	18.6	42.5
Game 8	73	5.6	19.9	59.0
Game 8	128	6.7	18.8	50.6
Game 8	202	2.3	10.6	67.4
Gartina 2	130	4.7	12.7	30.8
Gartina 2	205	5.2	12.9	30.1
Gartina 2	290	4.6	17.4	39.9
Gartina 1b	377	10.1	36.1	91.0
Gartina 1b	483	10.1	32.0	92.7
Gartina 1b	585	16.2	59.0	590
Raven 1	8	12.1	31.3	65.0
Raven 1	235	14.5	40.0	98.1
Raven 1	392	8.5	31.2	140.0
Trocadero Sec 21	0	6.7	17.9	43.9
Trocadero Sec 21	135	15.3	41.8	100.0
Trocadero Sec 21	316	8.0	25.7	79.8
Trocadero Sec 26	0	8.9	30.2	96.0
Trocadero Sec 26	105	11.4	27.9	83.6
Trocadero Sec 26	255	12.3	37.4	103.7

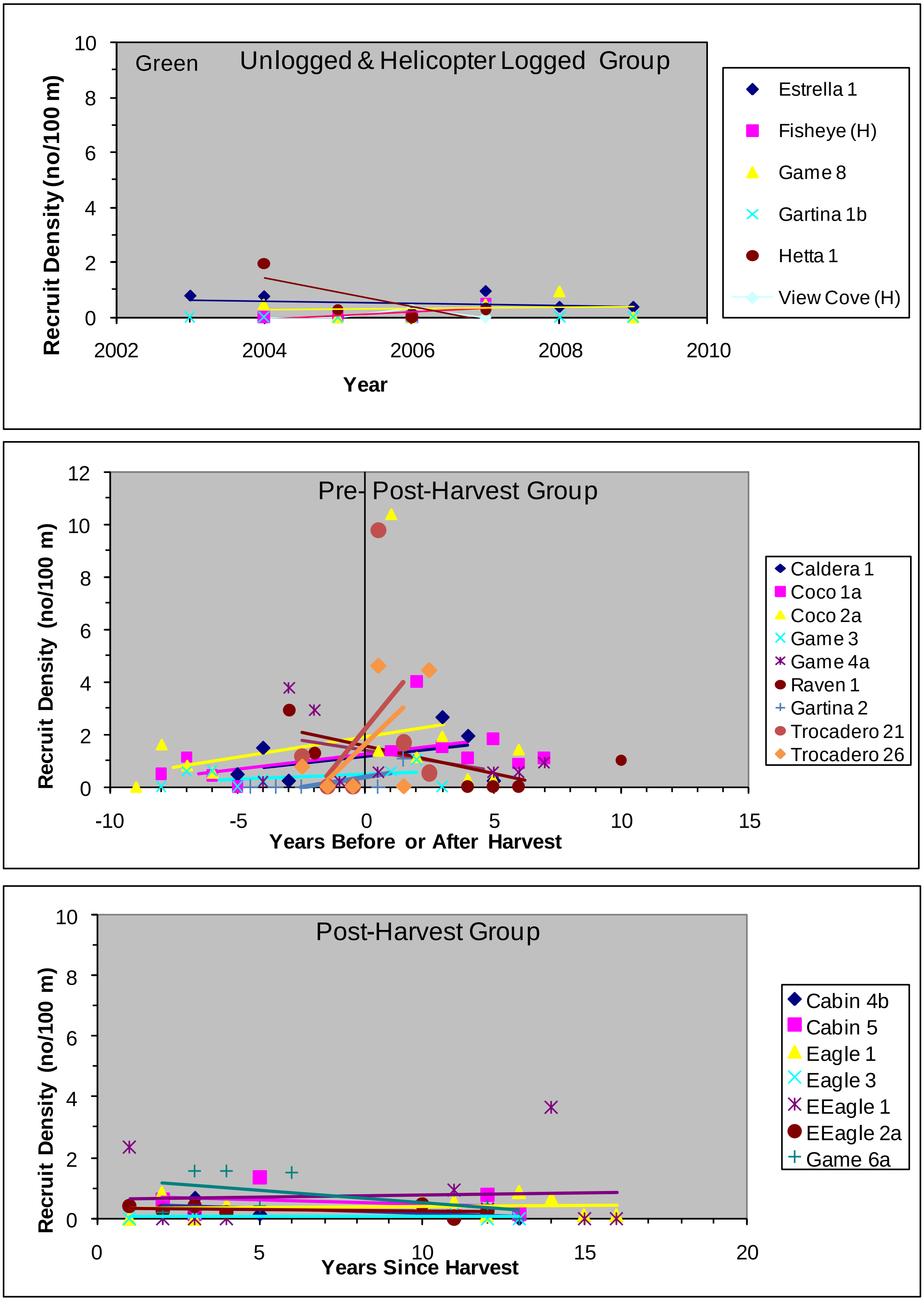


Figure 2. Trends in LWD recruit density for green decay class by harvest group.

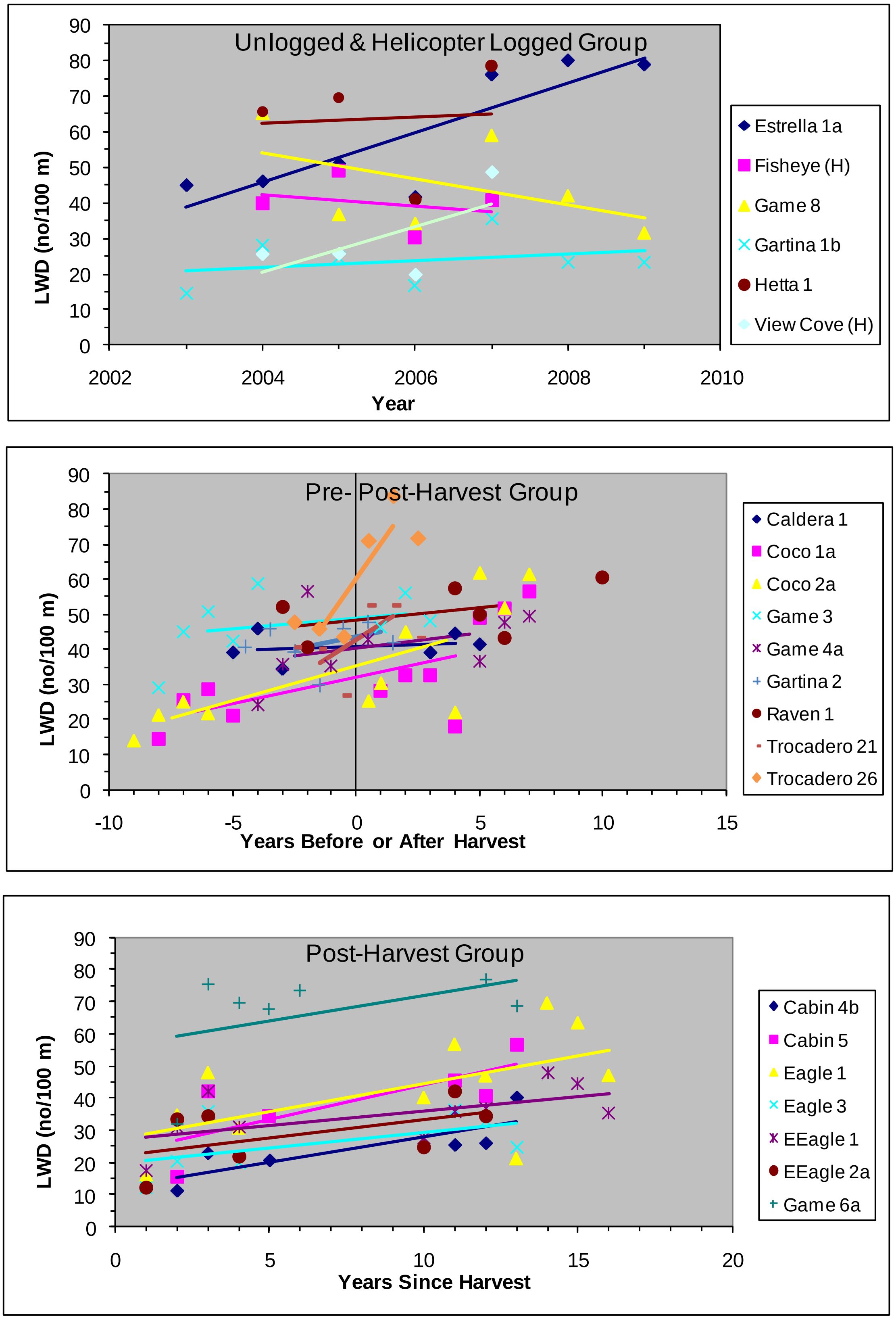
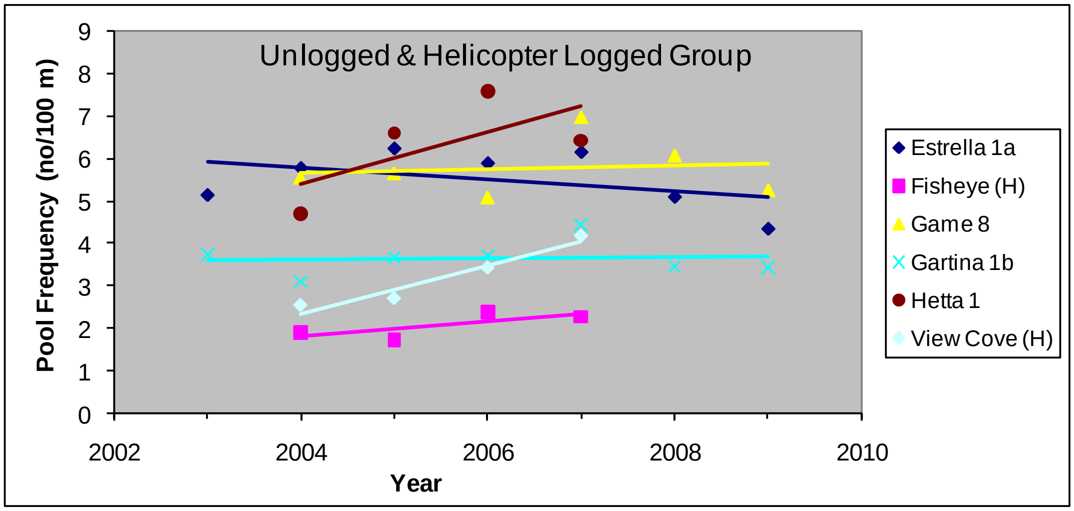
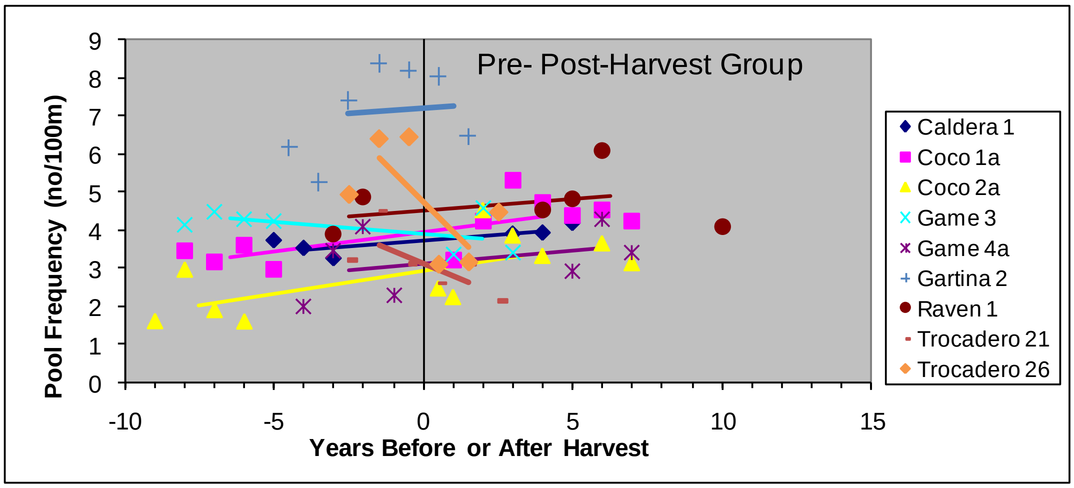


Figure 3. Trends in in-stream LWD density by harvest group.





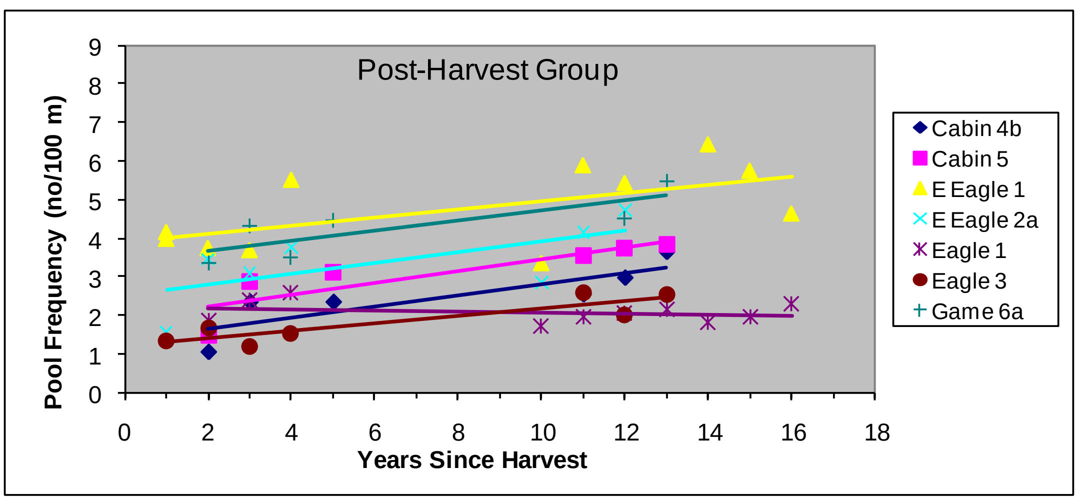


Figure 4. Trends in pool frequency by harvest group.

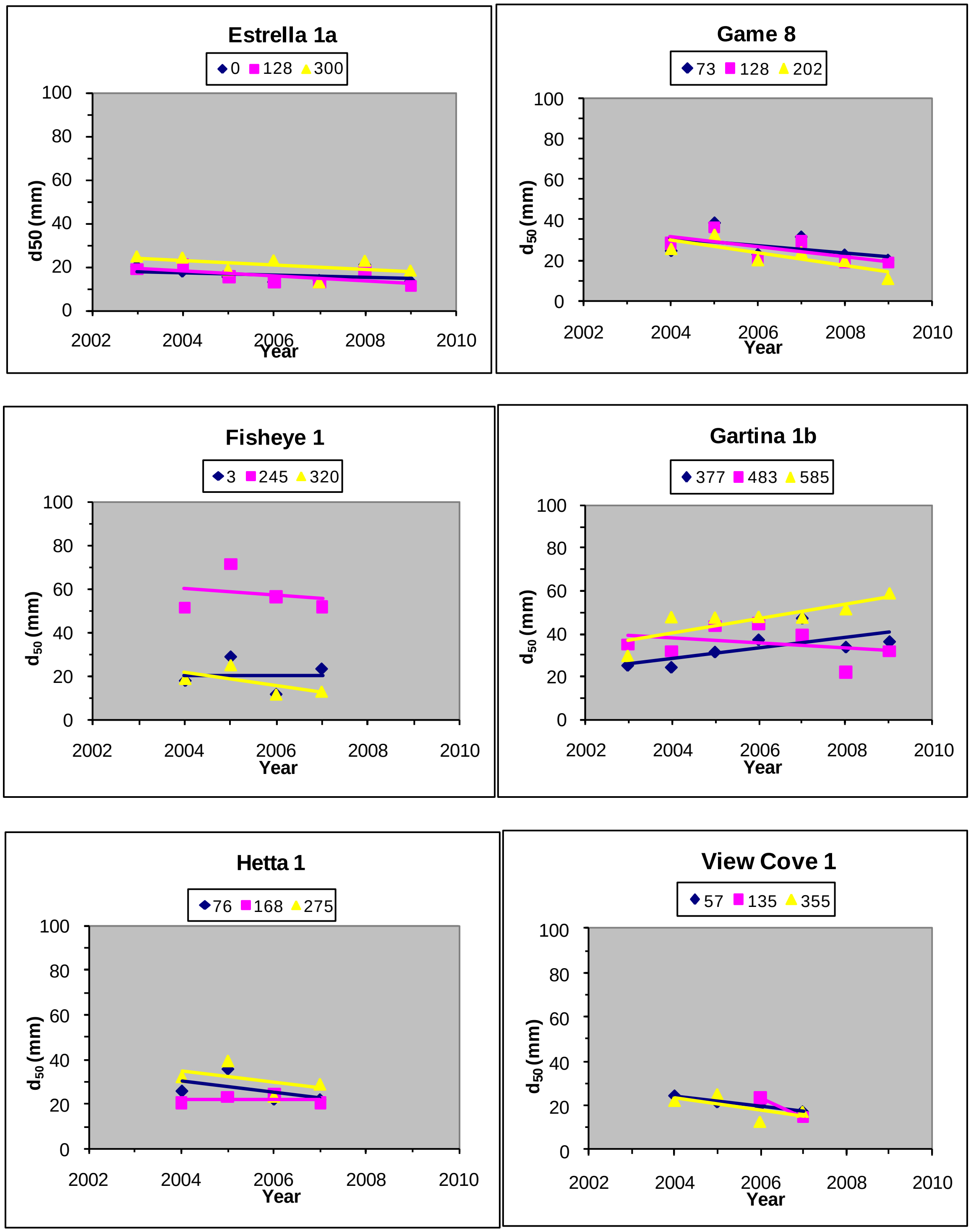


Figure 5. Trends in substrate size d_{50} at the unlogged and helicopter logged sites.

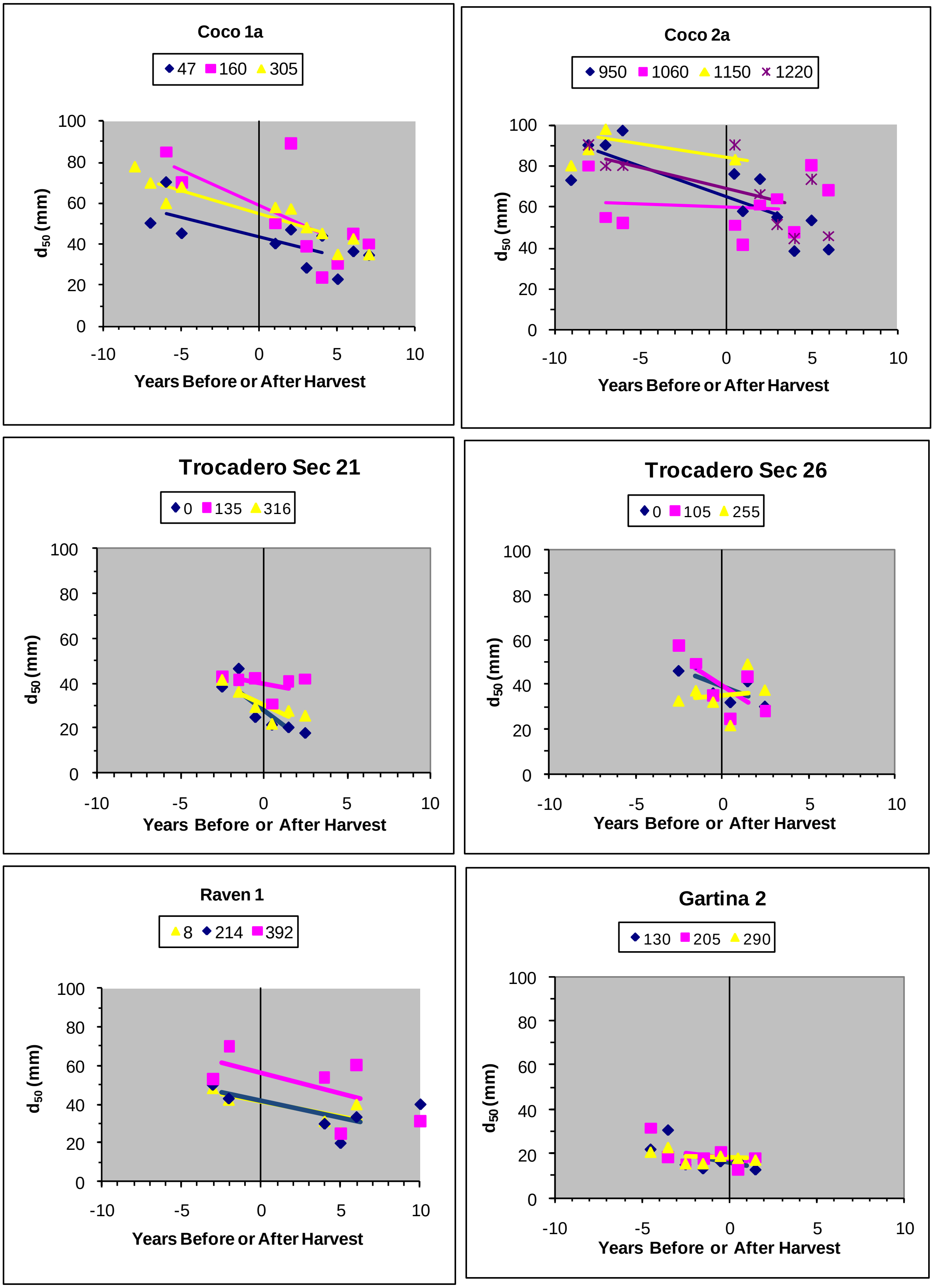
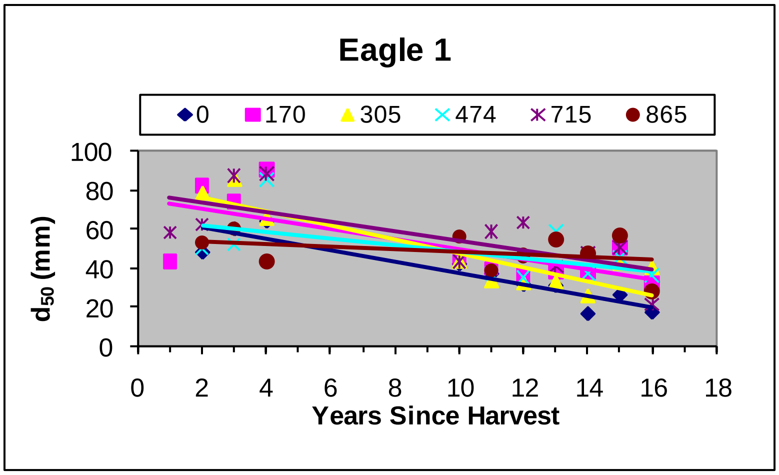


Figure 6. Trends in substrate size d_{50} at pre- post- harvest reaches sampled during 2009.



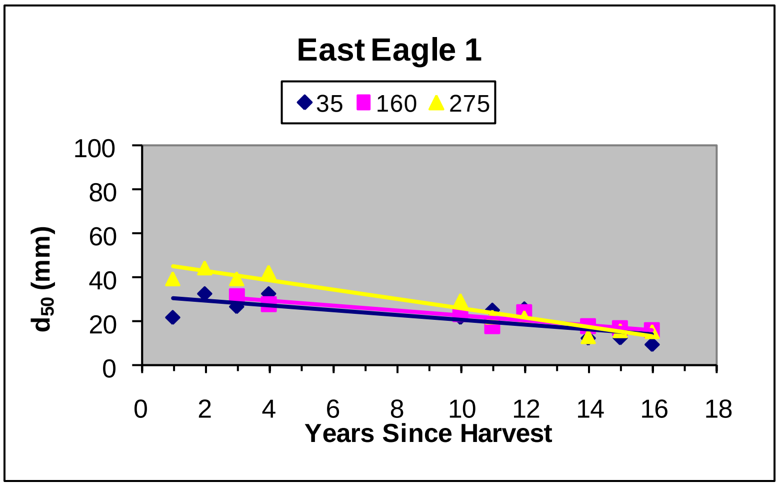


Figure 7. Trends in substrate size d_{50} at post-harvest sites sampled during 2009.

5.0 FUTURE MONITORING

Over the past several years, we shifted to an alternating (pulsed) monitoring schedule. We established two monitoring groups: one group of stream reaches (annual panel) that would be monitored annually, and a second larger group (pulsed panel) that would be monitored on a pulsed schedule (Table 8). All study reaches (existing and newly established in 2003-2004) were surveyed during a pulse period that was three to four years long (2003 to 2006). During 2007 through 2009, we continued monitoring at most of the newly established study reaches but reduced the number of surveys at the old study reaches. The latter subset of reaches forms the annual panel. The pulsed strategy was implemented to minimize monitoring cost over time yet maintain our ability to detect trends (Bryant 1995). Annual monitoring was maintained at several reaches to document habitat changes that may occur in response to major storm events during the pulse intervals. We learned from our past studies (Martin and Shelly 2005) that knowledge of storm related impacts can help us to interpret how habitat responses relate to logging versus natural environmental processes.

The last trend analysis that included all 22 monitoring reaches was performed after the 2005 season (see Martin and Shelly 2006). At that time we had seven study reaches in the post-harvest group, six reaches in the pre- post-harvest group, and nine reaches that were unlogged. Since that time, logging with standard buffers was implemented at three reaches (Gartina 2, Trocadero S21, and Trocadero S26) and helicopter harvest occurred near two reaches (Fish Eye and View Cove). Consequently, we now have nine reaches in the pre- post-harvest group, each with several years of data before and after harvest. Three reaches remain in the unlogged group and two have helicopter only harvest. The riparian stands at the helicopter harvest sites are undisturbed by harvest and have conditions that are similar to the unlogged sites (i.e., low disturbance from windthrow and LWD recruitment) and probably could be considered reference sites pending a more thorough evaluation.

Since more sites have been logged and monitoring has not occurred for four years at all study sites, we propose a full-station survey be implemented in 2010. Furthermore, we propose a comprehensive trend analysis similar to Martin and Shelly (2005) be performed for all old and new study sites. These data should provide an initial (i.e., few years after logging) and longer term (i.e., approximately 15 years after logging) evaluation of how riparian buffers and aquatic habitat respond to logging. We proposed continuation of the full-station survey after 2010 pending the findings of the comprehensive analysis. Because inter-annual variability can influence the detection of trends it is not known if one year of data from the full set of stations will be sufficient for interpretation.

In the future, we suggest that the monitoring program shift focus from evaluation of buffer effectiveness to the cumulative effectiveness of FRPA to protect aquatic habitat. In addition to buffers, the effects of watershed-scale disturbances on habitat from natural and logging-related mass wasting should be evaluated. The trend monitoring reaches are all located in the lower reaches of the study watersheds. Habitat conditions in these reaches are not only influenced by buffer characteristics, but by inputs of sediment and LWD from upstream disturbances. We have mass wasting data for some of the study watersheds from a previous survey (Perkins 1999). However, to facilitate a cumulative analysis, we recommend that this survey be updated and include all of the monitoring watersheds.

Area	Stream	Ch. Type	Harvest Year	Existing Monitoring Schedule 94	95	96	97	98	99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	Proposed Schedule 10	11	12	13	14	15
Post-Harvest Data Group																									
Craig	Cabin 4b	FP	1992	X	X		X						X	X	X										
Craig	Cabin 5	FP	1992	X	X		X						X	X	X										
Hoonah	Eagle 1	MM	1993	X	X	X	X						X	X	X	X	X	X	X						
Hoonah	Eagle 3	MM	1993	X	X	X	X							X	X	X									
Hoonah	E. Eagle 1	FP	1993	X	X	X	X						X	X	X		X	X	X						
Hoonah	E. Eagle 2a	MM	1993	X	X	X	X						X	X	X										
Hoonah	Game 6a	FP	1992	X	X	X	X	X						X	X										
Pre- and Post-Harvest Data Group																									
Craig	Caldera	MM	2000		X	X	X						X	X	X										
Craig	Coco 1a	MM	2002	X	X	X	X						X	X	X	X	X	X	X						
Craig	Coco 2a	MM	2003	X	X	X	X						X	X	X	X	X	X	X						
Hoonah	Game 3.	MM	2002	X	X	X	X	X					X	X	X										
Hoonah	Game 4a	MM	1998	X	X	X	X	X					X	X	X										
Craig	Raven	MM	1999			X	X						X	X	X				X						
New Pre- and Post-Harvest Data Group																									
Hoonah	Game 8	MM	---				X							X	X	X	X	X	X						
Hoonah	Gartina 1b	MM	---										X	X	X	X	X	X	X						
Hoonah	Gartina 2	FP	2008										X	X	X	X	X	X	X						
Craig	Estrella	FP	---		X	X	X						X	X	X	X	X	X	X						
Craig	Fish Eye	MM	2007											X	X	X	X								
Craig	Hetta	MM	---											X	X	X	X								
Craig	Trocadero S21	MM	2007											X	X	X	X	X	X						
Craig	Trocadero S26	MM	2007											X	X	X	X	X	X						
Craig	View Cove	MM	2007											X	X	X	X								

Unlogged | Conventional Logged | Helicopter

Table 8 **Existing and proposed future trend monitoring schedule by analysis group, timber harvest period, and survey time.**

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