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Delta Smelt in a Newly-created, Flooded Island in the Sacramento-San Joaquin Estuary, Spring 1993

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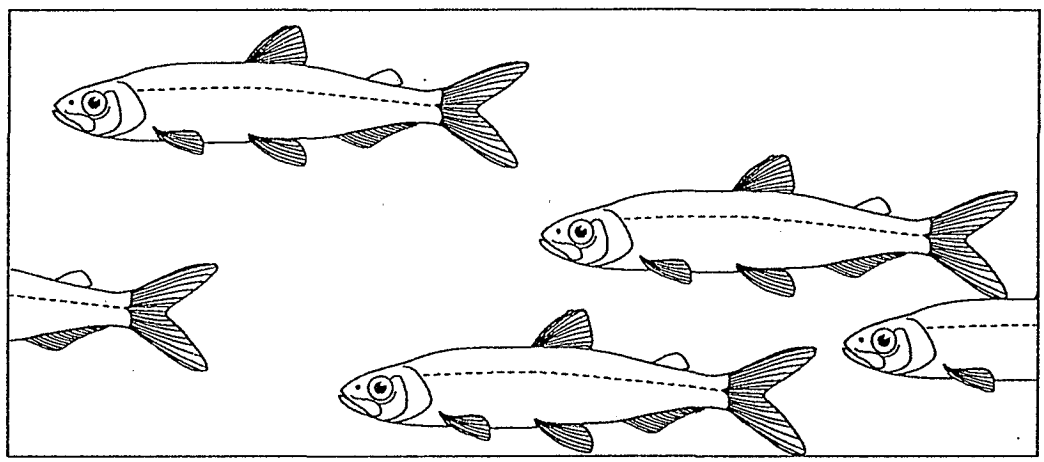
September 1993



From DWR
Kate Hansel
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BioSystems

BIOSYSTEMS ANALYSIS INC.

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DELTA SMELT IN A NEWLY-CREATED, FLOODED ISLAND IN THE SACRAMENTO – SAN JOAQUIN ESTUARY, SPRING 1993

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1.0 INTRODUCTION

1.1 OBJECTIVES OF THE STUDY

BioSystems Analysis, Inc. (BioSystems) was contracted by the California State Department of Water Resources to conduct field sampling studies for adult delta smelt (*Hypomesus transpacificus*) in a newly-created "flooded island" area in the northwest Sacramento-San Joaquin Estuary. Work was conducted on four days from 31 March to 14 May 1993.

The objective of our research was to determine whether adult smelt inhabit the flooded island during the spawning season and whether they concentrate in the island more than in the adjacent sloughs. Fish sex and spawning condition were determined and several physical parameters of the island sites were measured. We compared the results of our study to data collected by the California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service (USFWS).

1.2 BACKGROUND

Delta smelt were added to the federal list of threatened species in March 1993. As a species of special concern, it is important to determine spawning locations in the Delta so habitats can be protected or new ones created.

As part of the growing concern over delta smelt, BioSystems was contracted to design a culture program (Lindberg 1992). As part of this work we collected delta smelt brood stock in winter and spring 1992, using a modified beach seine technique. During our collection trips, we found high densities of adult delta smelt in two locations in the sloughs just northwest of Rio Vista. One was the mouth of Miner slough, just north of its junction with Cache Slough, and the other was the newly-created flooded island at the junction of Cache and Shag sloughs (Figure 1-1).

The flooded island was created by the U.S. Army Corp of Engineers (COE) to mitigate for losses of riparian habitat caused by reinforcing the flood control levees of the Delta (COE 1990). The majority of fish were captured during ebb tide at the inlet to this flooded island site. Many of the fish we caught were ripe or nearly ripe, which was not surprising since smelt migrate into freshwater for spawning. Although we suspected that the flooded island may be exploited by delta smelt for spawning, it had been sampled only cursorily by USFWS staff on 24 April 1992, no smelt were captured.

The primary objective of our study was to determine whether adult smelt inhabit the flooded island during the spring spawning season. Several sites inside the flooded island were sampled during spring 1993. Fish sex and spawning condition were determined and this information was compared to studies conducted by state and federal agencies.

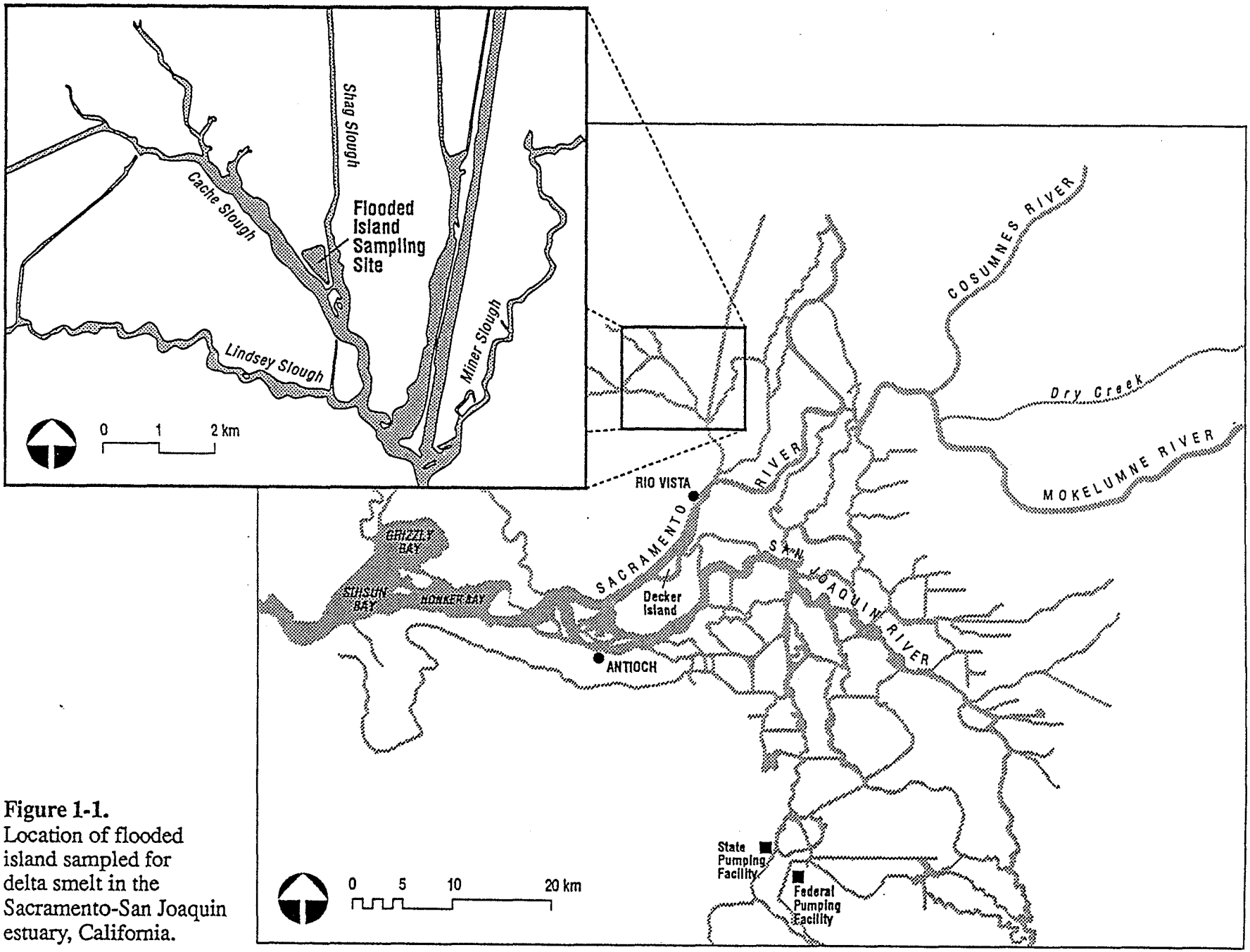

Figure 1-1.
Location of flooded island sampled for delta smelt in the Sacramento-San Joaquin estuary, California.

2.0 METHODS

Six sites in the vicinity of the flooded island were chosen for sampling (Figure 2-1). These sites were near the inlets where we had collected delta smelt in the past (Lindberg 1992). The sample sites are:

Site 0 "Control site," approximately 700 m north of the Shag Slough inlet, in Shag Slough.

Site 1 "Shag Slough outside," just outside the Shag Slough inlet.

Site 2 "Shag Slough inside," just inside the Shag Slough inlet.

Site 3 "Central site," in the center of the flooded island.

Site 4 "Cache Slough inside," just inside and south of the Cache Slough inlet, along the tules.

Site 5 "Cache Slough outside," just outside the Cache Slough inlet.

These sites were sampled on 31 March, 9 April, 27 April, and 14 May, 1993, during flood, slack or ebb tides (Appendix A). On 9 April, we conducted an additional night sampling. BioSystems biologists were assisted by the CDFG, which provided a boat and driver for all sampling trips.

We used a modified purse seine technique, that has proved effective in previous delta smelt collecting studies (Lindberg 1992). We set and retrieved a 6 or 8 ft deep beach seine from the bow of a skiff in open water. The 6 ft net was used for all collections, except on 9 April, when deeper water required the use of the 8 ft net. Both nets were 100 ft long, 3/16 in. knotless nylon mesh. At each sample site, the net was pulled for 5-7 min at a speed of about 1 knot. The net was then collected to the bow of the boat for inspection.

To avoid injuring the fish, we identified and counted them while the seine was in the water. All delta smelt collected then were transferred to a holding container for length and sex determinations. The sex of each delta smelt was determined by scientists familiar with the spawning characteristics of this species. Although delta smelt have no primary sexually dimorphic traits, the sex can be determined with reasonable accuracy by secondary traits. Fish were counted as females if they showed distended abdomens or were releasing eggs, and as males if they were releasing milt. Some fish without evidence of gametes were sexed by subtle differences in body form (Lindberg 1992).

Following length and sex determinations, delta smelt were either released (31 March) or transported to the University of California, Davis, for spawning or further histological examination of sexual maturation (9 April, 27 April, and 14 May). The histological work is part of a separate ongoing study (R. Mager, pers. comm.).

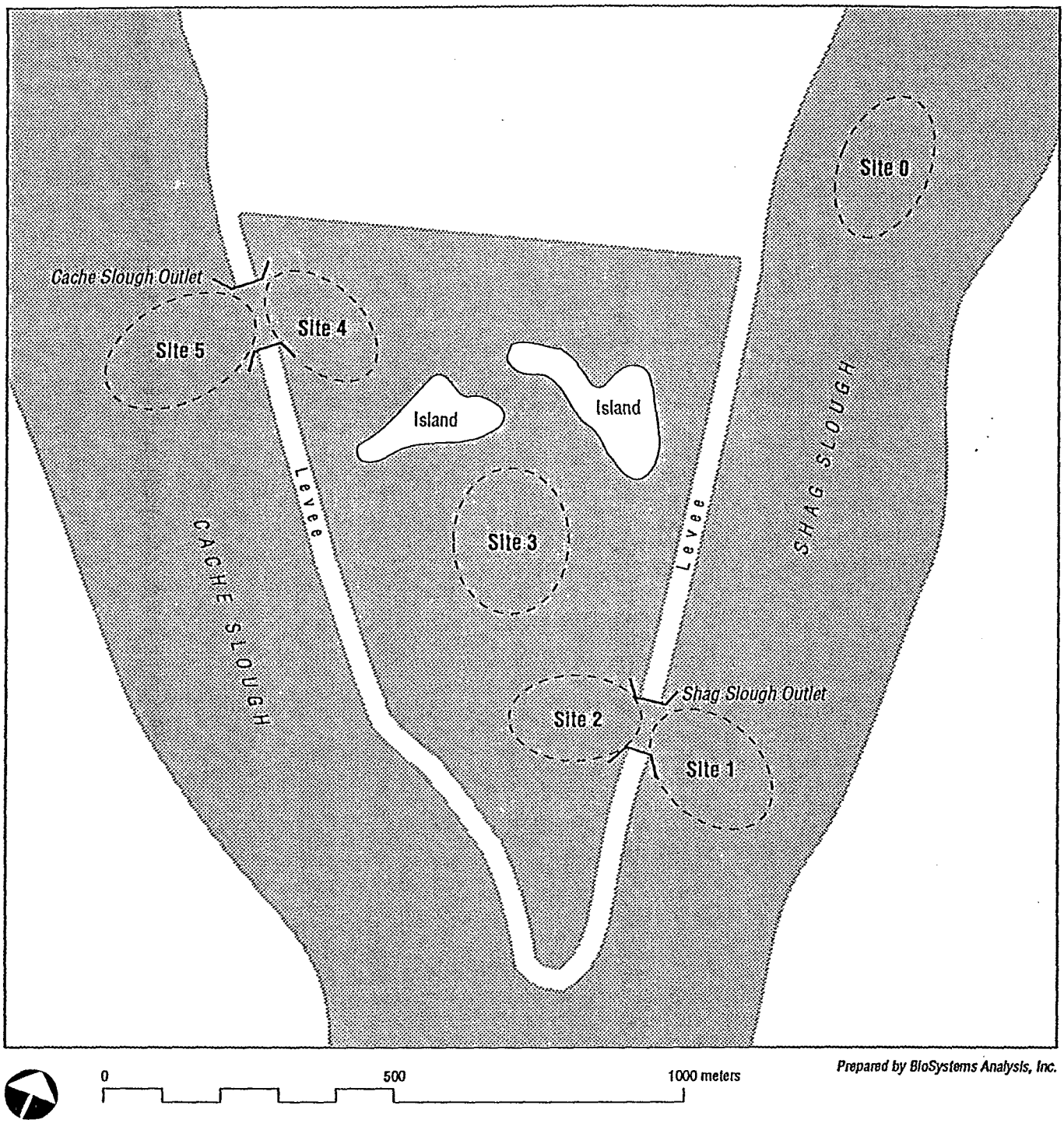

Figure 2-1. Location of six sampling sites in the flooded island area.

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3.0 RESULTS

We found adult delta smelt on the flooded island during the spring 1993 spawning season. Most were found near the inlet, particularly just south of the Cache Slough inlet inside the flooded island at Site 4 (Figure 3-1). This site had the highest catch, averaging 3.6 smelt/haul (s.d = 3.7); this number is significantly higher than that recorded at the other sites (Student-Newman-Keuls, $p<0.05$). On 14 May, we collected an average of 8.0 (s.d. =2.6) delta smelt per haul (Figure 3-2), the highest catch rate of our study.

All smelt collected were either sexually mature or recently spent. Of the 58 fish collected, 32 (55.2%) were female, 20 (34.5%) were male and 6 (10.3%) could not be sexed. The average fork length was 71.1 mm; females were slightly larger than males (Figure 3-3).

Thirteen species of fish were collected in the flooded island (Table 3.1). Inland silversides (*Menidia berylina*) comprised over half (58%) of the catch, followed by threadfin shad (*Dorosoma petenense*) (18%) (Table 3.1). Delta smelt comprised 11 percent of the total number of fish caught. As can be seen from our results, delta smelt were usually found in association with silversides and threadfin shad.

Since surveys were conducted at at ebb, flood, and slack tides, water depth varied. We never sampled in water less than 0.9 m deep because of difficulty in maneuvering the boat. The ranges and average of depths recorded at each site are summarized in Table 3.2. Inside the flooded island (Sites 2,3,4), depths ranged from 0.9 to 2.9 m (Table 3.2). Sites 1 and 5, just outside the inlet areas, were slightly deeper, averaged 4.0 and 2.8 m, respectively. The control site in Shag Slough had an average depth of 7.0 m.

More than half of the smelt (58.6%) were captured in depths between 0.9 and 2.0 m. This trend may not be meaningful, however, since most of the sampling (45% of all hauls) took place in this depth range. Furthermore, net efficiency increases in shallower water since fish can escape underneath the net in deeper water.

Air temperature ranged from 13-24°C and water temperature ranged from 14-24°C. Difference between surface and bottom temperatures ranged between 0.5 and 1.0°C.

Water clarity was low, averaging only 0.8 ft at all sites. Electrical conductivity measurements varied slightly with river and tidal flow, ranging between 150 and 550 micro Siemens/cm EC (mS/cm EC). These measurements show that the water in the flooded island is fresh. Conductivity varied little between sites or from surface to bottom (0-20 mS/cm EC, 31 March).

Fewer fish were caught during our 9 April night sampling than in day samplings. Two fish were collected during the night (0.4 fish/haul) while 13 fish were caught in 14 hauls during the day (0.9 fish/haul). Lower fish yields may be a result of the difficulties associated with sampling at night (such as poor visibility).

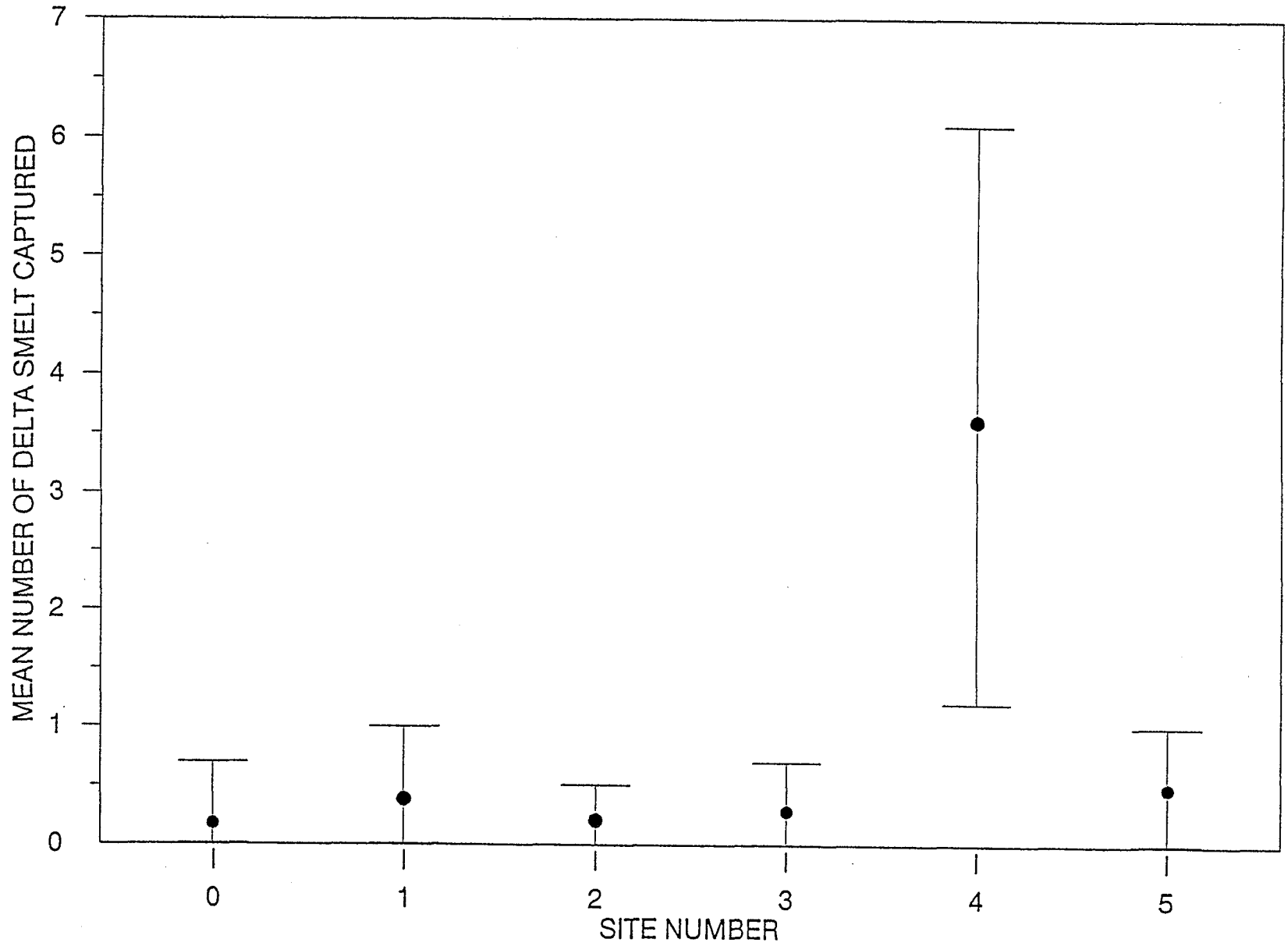

Figure 3-1. Mean number (and associated 95% confidence intervals) of delta smelt captured at each sampling site on all sampling dates combined in the flooded island between Shag and Cache sloughs, spring 1992

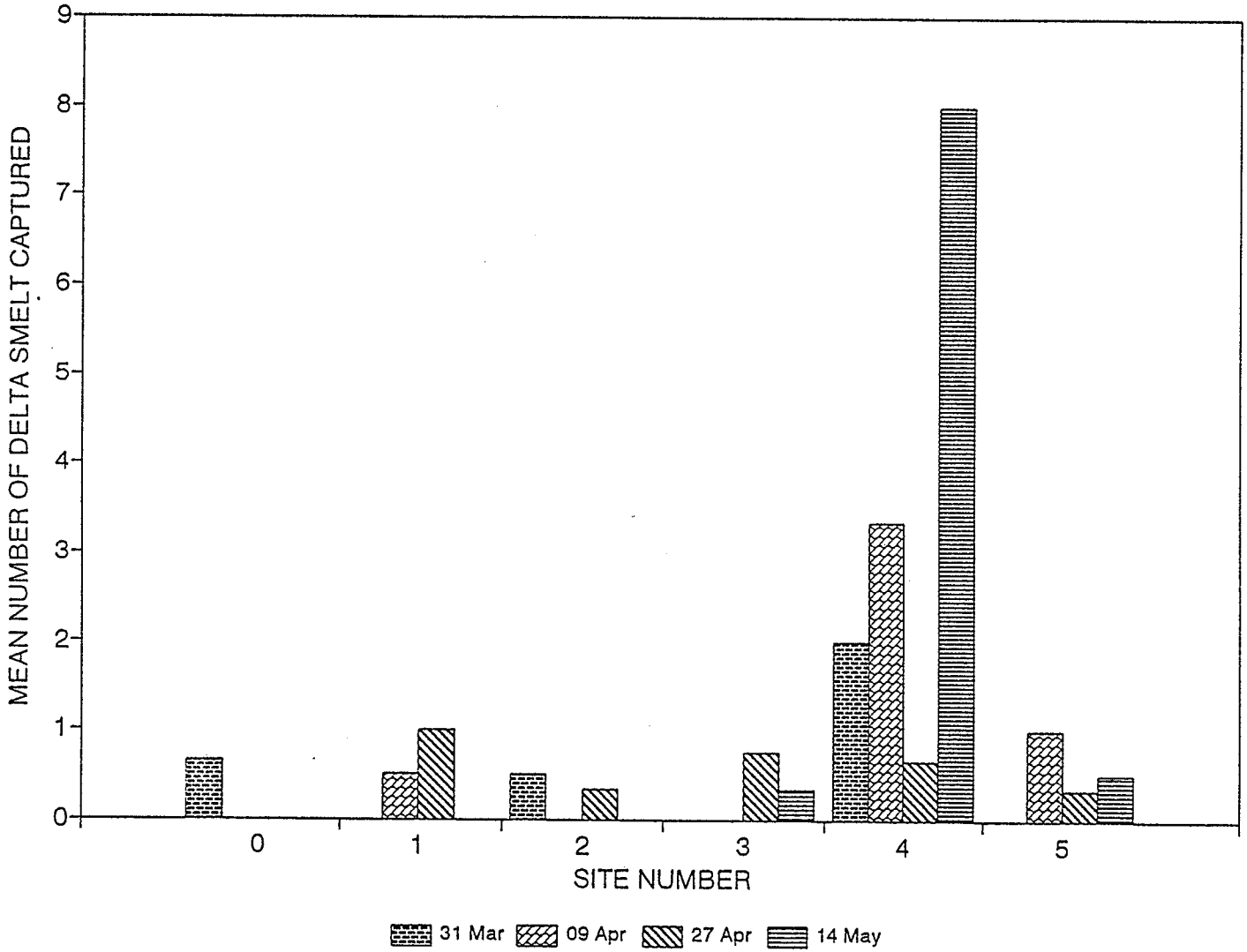

Figure 3-2. Mean number of delta smelt captured per sampling site and for each date in the flooded island between Shag and Cache sloughs, spring, 1993.

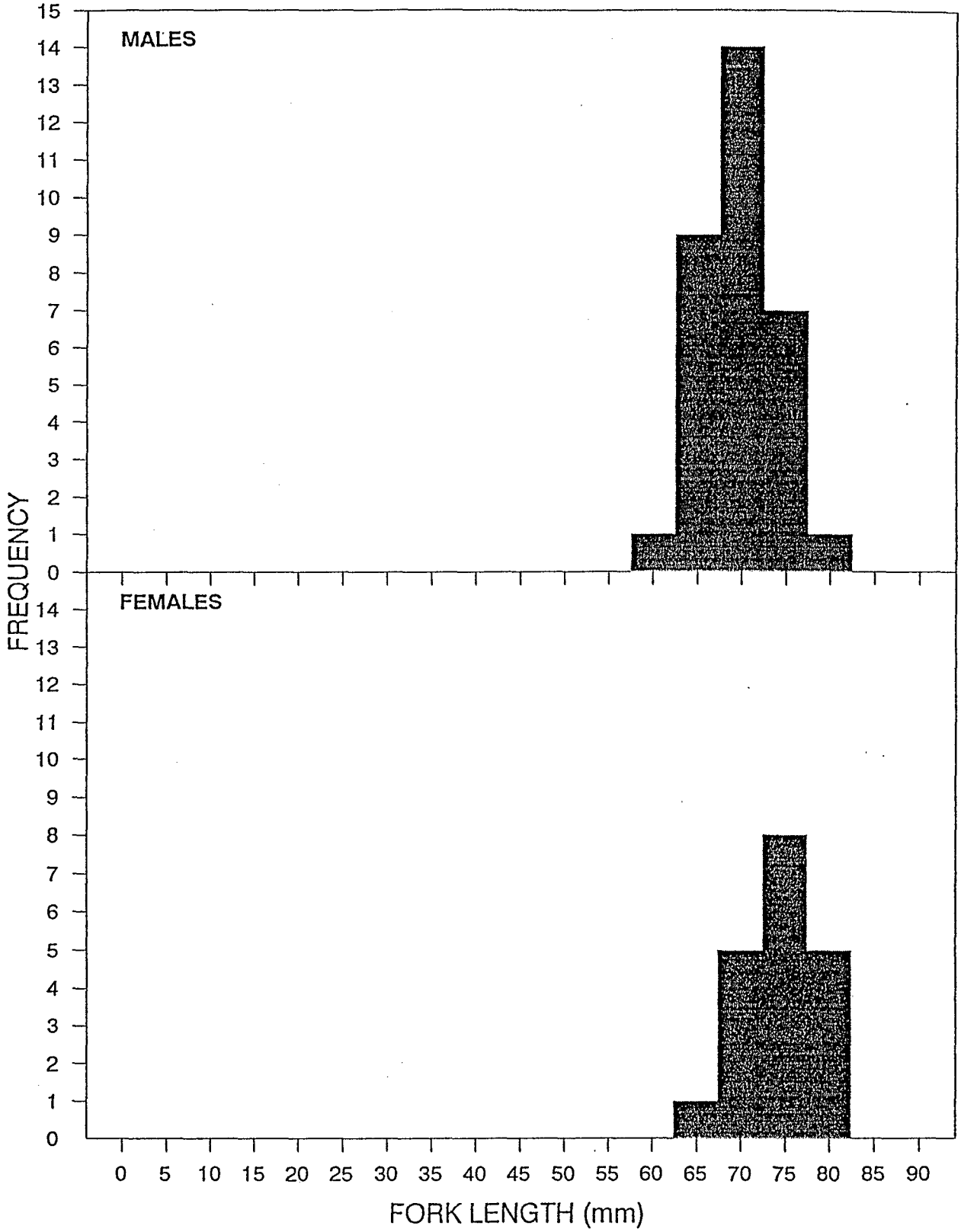

Figure 3-3. Length frequency of male and female delta smelt captured in the flooded island.

Table 3.2. Average and range of water depths (m) recorded at each sampling location in the flooded island. Standard deviations (SD) are reported in parentheses.

SITE	AVERAGE DEPTH (SD)	RANGE OF DEPTH
1	4.0 (0.9)	2.1 - 5.5
2	1.8 (0.4)	1.2 - 2.7
3	1.9 (0.5)	1.2 - 2.9
4	1.6 (0.5)	0.9 - 2.6
5	2.8 (1.1)	1.2 - 4.6
0 (Control)	7.0 (1.1)	4.7 - 8.5

4.0 DISCUSSION AND RECOMMENDATIONS

Adult delta smelt are in the newly-created flooded island near the junction of Shag and Cache Sloughs in the Delta. The area appears to provide good spawning habitat for smelt as evidenced by the presence of females with eggs and males with running milt. We also found post-spawn animals in the flooded island. Additionally, the USFWS found seven juvenile delta smelt (about 25 mm) in the flooded island this spring (M. Fris, pers. comm.). These fish are probably a result of spawning in the flooded island. The occurrence of both pre- and post-spawn animals in the flooded island supports the claim that smelt use this area for spawning and not just for feeding or staging.

Evidence of spawning in nearby sloughs also suggests that delta smelt could be using the flooded island for spawning. Larval smelt were collected by DWR and CDFG during the 1993 spring spawning season in nearby Barker and Lindsey sloughs. Smelt were caught from 25 March and periodically throughout the spring season (Spaar 1993, pers. comm.). The length distribution of larvae in Lindsey Slough did not change over time, indicating that spawning occurs over a prolonged period, at least until mid-May. Since the habitat in Barker and Lindsey Sloughs is similar to that of nearby Cache Slough (Lindsey Slough eventually flows into Cache Slough), it is likely that spawning, egg development and larval rearing all occur in the flooded island.

It was beyond the scope of our survey to correlate the presence of delta smelt with physical parameters such as tidal conditions, water temperature, time of day, water clarity, or conductivity. Our measurements give a range of conditions in which smelt are found, but we cannot attribute fluctuations in smelt abundance to these parameters. Measurements varied more from day to day than from site to site, which makes statistical comparisons meaningless. Water depth appears to be the only factor in our study correlated with the number of smelt collected. Most smelt were caught at a depth of about 0.9 and 2.0 m; however, our sampling methods and materials were designed to be most effective in this depth range.

Other factors also may influence smelt density in spawning areas, including proximity to emergent vegetation and tidal currents. Emergent vegetation, which provides cover for ripe females, occurs in shallower waters such as at Site 4 where tules grow along the bank. Strong tidal currents occur near the inlet where more smelt were captured. Higher flows may be advantageous to broadcast spawners like delta smelt because flows distribute eggs and provide aeration.

It is difficult to determine to what degree spawning smelt the flooded island as compared to the neighboring sloughs. A rough determination can be made, however, by comparing the catch per haul from the CDFG's midwater trawl survey in Cache Slough to the catch per haul in the flooded island. The volume of water sampled per tow for the midwater trawl was estimated as 7,200 m^3/tow (from Stevens 1977), whereas the volume for the modified beach seine technique was roughly 340 m^3/tow. The total catch was 5 fish/13 tows in Cache Slough (CDFG unpublished data) and 56 fish/56 tows in the flooded island. Adjusting for differences in volume sampled, we calculate two orders of magnitude more fish in the flooded island than in the

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APPENDIX A.

SEINING DATA COLLECTED BY BIOSYSTEMS ANALYSIS, INC.

Appendix A. Seining data collected by BioSystems Analysis, Inc., in the flooded island between Cache and Shag sloughs, spring 1993.

			TEMPERATURE (C)				CONDUCTIVITY		TIME		SILVER	TF	DELTA	TULE	CHINOOK	LOG	CHAM	WHITE	STICKLE	SACRA	GOLDEN	PRICKLY	SCULPIN		UNK	UNK
Date	Site	Tide*	Air	Water	Depth (ft)	Secchi (ft)	Surf.	Bott.	Begin	End	SIDE	SHAD	SMELT	PERCH	SMOLT	PERCH	GOBY	CAT	BACK	SUCKE	SHINER	SCULPIN	FRY	BLUEGILL	MINNOW	FRY
31-Mar	0	2	14	14	>20	1	150	155	08:43	08:47	1	1														
31-Mar	0	2							08:52	08:57	2	4														
31-Mar	1	2		14	18	1	155	160	09:11	09:13	13															
31-Mar	2	2		15	8.8	1	170	180	09:26	09:28	6	3														
31-Mar	3	2		14.5	9.6	0.7	180	180	09:43	09:46	4	2														
31-Mar	4	2		14.5	6.2	0.6	220	230	10:18	10:20	3	3	4													
31-Mar	5	2	17	15	15.2	0.7	210	230	10:40	10:42		7														
31-Mar	1	2		16	10	0.7	220	205	11:50	11:54	9	1														
31-Mar	3	0		15.5	6	0.7	220	220	12:04	12:09																
31-Mar	0	1	18	15	>20	0.9	155	160	12:25	12:28	1		2													
31-Mar	1	1			14.6				12:43	12:48	8															
31-Mar	2	1			6.5				12:55	12:58	8	4	1													
31-Mar	3	1			7.8				13:08	13:14	7															
31-Mar	4	1			5.1				13:26	13:29	1															
31-Mar	5	1			11				13:40	13:44	11	3			1											
										TOTAL	74	28	7	0	1	0	0	0	0	0	0	0	0	0	0	0
09-Apr	0	2	18	17	24	1.7	360		16:00	16:05	28															
09-Apr	1	2		17	12	1.1	360		16:15	16:20			1													
09-Apr	1	2							16:20	16:25																
09-Apr	2	2		17	5.4	0.9	360		16:30	16:40																
09-Apr	3	2		16.5	5.8	1	360		16:50	16:55																
09-Apr	4	2		16.5	4	0.8	410		17:00	17:07	4		1													
09-Apr	5	2	18	16	7	0.9	395		17:15	17:20	3		1													
09-Apr	0	2		17	28	1.7	355		18:00	18:08																
09-Apr	1	2	16	16	16	1.1	345		18:10	18:17	2		1		1											
09-Apr	2	2		17	6.5	1	370		18:25	18:30	2	6														
09-Apr	2	2							18:35	18:43	16	6														
09-Apr	3	2		16	6.4	0.9	370		18:50	18:58	8															
09-Apr	4	2		16	5.7	1	360		19:04	19:12	22	19	7	2												
09-Apr	5	2		15.5	15	1	340		19:23	19:30	13	1	2													
09-Apr	1	0	13	15.5	7		335		20:30	20:39	1					2										
09-Apr	2	0							20:45	20:50		1														
09-Apr	3	0			5				20:55	21:03	11															
09-Apr	4	0		15	5		400		21:11	21:20	8		2				2	1								
09-Apr	5	0		16.2					21:28	21:35	3	1														
										TOTAL	121	34	15	2	1	2	2	1	0	0	0	0	0	0	0	0
27-Apr	0	0	25	18	23	0.7	425		14:51	14:55	7															
27-Apr	1	0		18.5	12	0.5	430		15:03	15:07	1	3	3													
27-Apr	2	0		19	4	0.6	430		15:20	15:25	56				1											
27-Apr	4	0		19	3	0.5	420		15:47	15:51	1															1
27-Apr	5	0		19.5	4	0.5	460		16:00	16:04	1	5	1						1							
27-Apr	0	0	24	19.5	23	1	430		16:56	17:01		2							2							
27-Apr	1	2		18	12	0.7	410		17:08	17:11	5															
27-Apr	2	2			4				17:20	17:25					1											
27-Apr	3	2			3.6				17:31	17:35		1	1							1						
27-Apr	4	2		18	4	0.7	550		17:48	17:50		1														
27-Apr	5	2		18	5		550		17:56	18:00																
27-Apr	0	2	21	19	26	0.7	420		18:48	18:53	2				1											
27-Apr	3	2		19	5	0.6	420		19:03	19:07	6		2								1					
27-Apr	1	2		17	12	0.5	400		19:17	19:21																
27-Apr	2	2			5.5				19:26	19:30	4	2	1					1								
27-Apr	3	2		17.5	5.8		430		19:39	19:43	1															
27-Apr	3	2			6.4				19:49	19:53	3	1														
27-Apr	4	2		16.5	4		460		20:00	20:04	4	1	2					4								
27-Apr	5	2		16.5	8		420		20:15	20:18		2														
										TOTAL	91	18	10	0	3	0	0	5	3	1	1	0	0	0	0	1