Report 5

Fishes Associated with Submersed Aquatic Vegetation, *Egeria densa*, in the Sacramento-San Joaquin Delta in 1998 as Sampled by Pop Nets.

Prepared for California Department of Boating and Waterways

Prepared by Michael F. McGowan, Ph.D., Romberg Tiburon Center, San Francisco State University

Introduction

The recent proliferation of *Egeria densa*, a non-native submersed aquatic plant, in the marinas and waterways of the Sacramento-San Joaquin Delta severely impedes navigation by recreational boaters. Prior to undertaking eradication or control measures, the Department of Boating and Waterways (DBW) sought to determine the potential environmental impacts of an *Egeria* control project on fishes that may use the *Egeria* as habitat.

Elsewhere fishes are known to use aquatic plant habitats. Some native California fishes such as Sacramento splittail use flooded vegetation for spawning; endangered delta smelt are suspected to spawn on or near aquatic vegetation, and juvenile salmon (some species endangered) are capable of using shallow water during their migrations through the delta. In general, shallow vegetated areas are considered important to small fishes for shelter from predators and production of prey items. Existing knowledge in 1997 was inadequate to evaluate the use by fish of shallow water habitats in the delta, especially for habitats dominated by non-native species such as *Egeria*. Therefore DBW began this study of fishes associated with *Egeria densa*.

The study had three objectives.

1. Describe the juvenile fish assemblage associated with *Egeria densa* at selected sites in the Sacramento-San Joaquin Delta
2. Determine if threatened, endangered, or sensitive native species rely on *Egeria densa* for important habitat values
3. Evaluate the relative effects on the *Egeria* fish community of selected experimental control methods tested by DBW.

Changes in *Egeria* biomass and aquatic inverterbrates are described in Obrebski, Irwin, and Pearson (1998). Aerial survey results are presented in the report by Foschi (1998).

Methods

Gear Selection

Conventional fish sampling gear such as trawls or electrofishing are considered ineffective in dense aquatic vegetation. Pop-nets were recommended in various sources, e.g., Dewey et al. (1989), Espegren and Bergersen (1990). Light traps are useful sampling devices for larval and juvenile fishes and have been used in flooded vegetation to sample Sacramento splittail in California (Randy Baxter, DFG, personal communication). After

some field trials, beach seines and purse seines were eliminated from consideration because few areas were suitable for beach seining and the purse seine proved unwieldy and ineffective during field tests in the selected treatment and control areas. Pop-nets and light traps were selected for use in this study. Additionally, the piles of *Egeria* mechanically harvested during DBW harvest experiments were sampled or sorted in their entirety for fish and macroinvertebrates.

Pop-nets

The pop-nets were constructed of 1.5 mm nylon mesh, 1 m square, and 3 meters deep. An additional 1 m depth of net with purse line at the bottom extended below the bottom frame. The top and bottom frames were made of PVC: the top frame was buoyant and the bottom frame was weighted. Pop-nets were deployed on the bottom in experimental areas during daylight hours. The nets were deployed in a collapsed mode with the top and bottom frames connected to each other and surrounding 1 square meter of "*Egeria* habitat."

After deployment, the nets were allowed to soak for 1 hr before releasing the top frame from the bottom frame with a trip line. The top frame "popped" to the surface enclosing a column of water 1 meter square. The bottom purse line was tightened, gathering in on any *Egeria* in the quadrat, and then used to draw the net up to the boat where fish were dip-netted out and the wet weight of *Egeria* in that sample was measured. Fish were identified and measured in total length and standard length then released alive back into the water. Fish that could not be identified in the field (e.g., too small) were returned to the laboratory for identification.

Light Traps

Plexiglass light traps similar to the published descriptions of the "quattrefoil" light trap were deployed at night, at least 1 hour after sunset, floating with chemical light sticks "cyalumes" as attractant. The light traps were anchored with a lead fishing weight attached to the trap with monofilament or nylon line. The traps were allowed to fish for at least 1 hr; the catch was standardized per hour of fishing time. The fish collected in the light traps were preserved in 2-5% formaldehyde solution and returned to the laboratory for identification and measurement.

Sorting Harvested *Egeria*

Truckloads of harvested *Egeria* were sorted by hand for fish and macroinvertebrates. One-half of each pile, randomly selected, was sorted for very large truckloads at the beginning of the study and entire piles were sorted later in the study, whether they were large or small.

Environmental Observations

Depth, water temperature, tidal currents, and weather conditions were recorded at each site when pop-nets or light traps were deployed.

Laboratory Analysis

Fish and invertebrates collected were identified under a dissecting microscope and measured. Total and standard lengths were measured on fish larvae, carapace width or other appropriate dimension was measured on crabs and other organisms. Larger fish and invertebrates sorted from the mechanically harvested *Egeria* were weighed and measured.

Data Processing

Field and laboratory data were entered into computer spreadsheets. Printouts of the spreadsheets were compared against the original data recording sheets and edited if necessary. Graphics and statistical analyses were done using the spreadsheet (MS Excel) and other commercially available software (e.g., Systat).

Results

Sample Locations and Number

Samples were collected from early May through late October at six different sites within the Delta (Table 1).

Table 1. Collecting gear, location, date and numbers of samples collected for DBW *Egeria* fish project during 1998.

Sample Type	Location	Date	Number of Samples
Mechanical harvest	Sandmound	5/12/98	4
	Owl Harbor	5/13/98	1
	White Slough	5/14/98	2
	Sandmound	7/28/98	1
	Owl Harbor	7/29/98	1
	White Slough	7/30/98	1
Pop-net	Big Break	6/10/98	4
		6/11/98	4
		7/24/98	8
		8/27/98	8
		10/15/98	8
	Frank's Tract	6/22/98	8
		7/23/98	8
		8/25/98	8
		10/12/98	8
		10/19/98	8
	Owl Harbor	5/2/98	4
		5/21/98	4
		5/29/98	4
		6/8/98	8
		6/17/98	4
		6/23/98	4
		7/15/98	9
		8/6/98	8

Sample Type	Location	Date	Number of Samples
		10/22/98	8
	Sandmound	5/2/98	4
		5/11/98	4
		5/22/98	8
		6/17/98	4
		7/17/98	8
		8/7/98	8
		10/21/98	8
	Little Venice	6/15/98	8
Pop-net	Little Venice	7/21/98	8
		8/24/98	8
		10/14/98	8
		10/20/98	8
	White Slough	5/13/98	4
		5/21/98	8
		6/12/98	8
		7/16/98	8
		8/12/98	8
		10/7/98	8
		10/21/98	4
Light Trap	Big Break	6/25/98	34
		8/27/98	8
		10/15/98	11
	Frank's Tract	8/25/98	8
		10/12/98	11
		10/19/98	9
	Sandmound	7/28/98	8
		8/7/98	8
		10/21/98	10
	Owl Harbor	7/29/98	8
		7/30/98	8
		8/6/98	8
		10/22/98	11
	Little Venice	8/24/98	8
		10/14/98	11
		10/20/98	11
	White Slough	7/30/98	8
		8/12/98	5
		10/7/98	8

Samples were collected on at least three dates in treatment and control areas at each location. There were 257 pop-net samples and 193 light trap samples collected during 1998. In the pop-net samples 2181 individual fish were collected; 840 fish were collected in the light traps, and 671 fish, crabs, and tadpoles were sorted from the harvested *Egeria*.

Fish Species Collected

There were 13 species of fishes collected during 1998. Of these, only the prickly sculpin is a native species, while the others are considered resident but non-native members of the Delta fish community (Table 2). An additional species, the goldfish, was collected from harvested *Egeria* in 1996. The brown bullhead was collected from harvested *Egeria* at Sandmound.

Catches were numerically dominated by the centrarchids (sunfish family): bluegill, redear sunfish, largemouth bass, and the schooling forage fish:threadfin shad and inland silversides. The small centrarchids were associated with the *Egeria* where they were collected in pop-nets. The forage fish were plentiful in the light trap collections, probably pursuing plankton attracted to the lights.

Table 2. Species of fish collected at each sample location.

Species	Big Break	Frank's Tract	Little Venice	Owl Harbor	Sandmound	White Slough
Blue gill	X	X	X	X	X	X
Redear			X	X	X	X
Largemouth	X	X	X	X	X	X
Black crappie				X	X	X
Warmouth				X	X	X
Golden shiner					X	
Red shiner	X			X		
Goldfish						
Cyprinidae					X	
Inland silverside	X	X	X	X	X	X
Killifish	X	X		X	X	
Mosquito fish	X		X		X	X
Threadfin shad	X		X	X	X	X
Brown bullhead					X	
Prickly sculpin	X			X		

No Delta smelt were collected although juveniles, if present, would likely have been collected because they would be expected to behave somewhat like the silversides and shad, that is, schooling and planktivorous, likely to be attracted to the light traps. No juvenile chinook salmon or steelhead were collected. No sensitive native species such as splittail were collected either. Splittail are known to use submerged flooded vegetation but none were collected in or near the submersed aquatic *Egeria*.

Treatment Effects

Big Break was sampled four times with pop-nets: June 10 and 11, July 24, August 27, and October 15. Sonar was applied inside the harbor while the control station was located outside the harbor. A 2-way analysis of variance (ANOVA) was run with factors date and

treatment. Date had 4 levels and treatment had 2:control and sonar. The raw data of numbers of fish per square meter were highly variable, ranging from 0 to 1283, so they were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. The results of the ANOVA indicated that there was no difference in fish abundance between sampling dates ($p = 0.66$)or between control and treatment areas ($p = 0.48$). The interaction was not significant ($p = 0.21$) indicating that it was acceptable to test the individual factors. Fish abundance was somewhat higher at the control area than in the harbor but it was also more variable among sampling dates. There was no trend up or down at either control or treatment area.

Frank's Tract was sampled five times with pop-nets: June 22, July 23, August 25, October 12, and October 19. Sonar was applied to an area in the northwest portion of Frank's Tract while the control stations were south of the treatment area closer to the boat launching area. A 2-way analysis of variance (ANOVA) was run with factors date and treatment. Date had 5 levels and treatment had 2:control and sonar. The raw data of numbers of fish per square meter ranging from 0 to 18 were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. The results of the ANOVA were that there was a significant difference in fish abundance between sampling dates ($p = 0.008$) but there was no difference between control and treatment areas ($p = 0.435$). The interaction was not significant ($p = 0.20$) indicating that it was acceptable to test the individual factors. Fish abundance was somewhat higher at the treatment area than in the control area but the average abundance was dominated by high catches in the treatment area July 23. There was no trend up or down at either control or treatment area.

Little Venice was sampled five times with pop-nets: June 15, July 21, August 24, October 14, and October 20. The initial survey was done before any chemical treatments were applied. According to my notes, Komeen was applied prior to the second survey and then Sonar was applied prior to the other surveys. A 2-way analysis of variance (ANOVA) was run with factors date and treatment. Date had 5 levels and treatment had 2:control and sonar. The raw data of numbers of fish per square meter ranging from 0 to 86 were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. The results of the ANOVA were that there was a significant difference in fish abundance between sampling dates: catches were higher July 21 ($p < 0.001$), and there was a difference between control and treatment areas ($p < 0.001$); catches were higher in the control area. However, the interaction was also significant ($p = 0.002$) indicating that it was not acceptable to interpret the individual factors without considering their interaction. Overall fish abundance was higher at the control area than in the treatment area but the results were strongly affected by the high catches of inland silverside and of threadfin shad in the control area July 21 paired with the near absence of fish at the treatment area on any of the five sampling surveys. Except for July 21, the catch was primarily bluegill, largemouth bass, and redear sunfish. There was no trend up or down at either control or treatment areas.

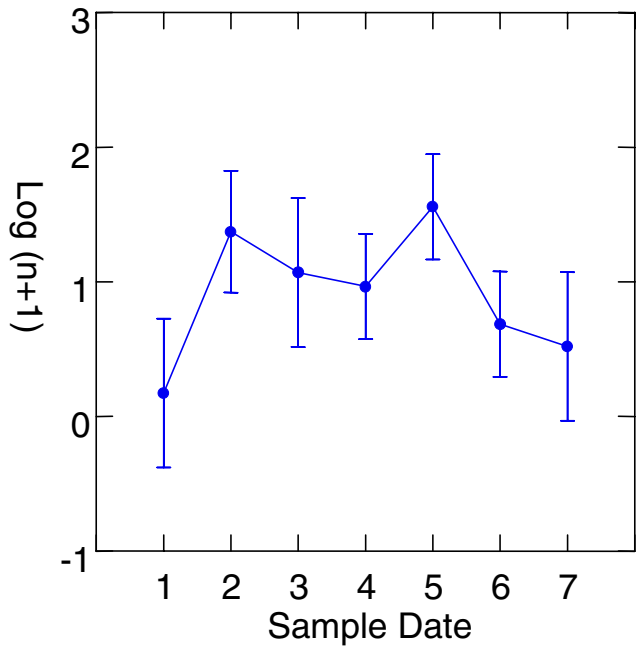
Owl Harbor (Sevenmile Slough) was sampled 9 times with pop-nets: May2, May 21, May 29, June 8, June 17, June 23, July 15, August 16, and October 22. According to my notes, four different kinds of treatments were applied: none(control), mechanical harvest, Reward, and Komeen. Sampling was conducted against a background of possible overlap of chemical treatments due to water circulation and a general decline in *Egeria* abundance locally perhaps independent from treatments. Three different statistical analyses were done on the Owl Harbor pop-net data. The raw data of numbers of fish per square meter ranging from 0 to 27 were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. A 1-way analysis of variance (ANOVA) was run with factor treatment. Treatment had 2 levels: control and other treatment (included mechanical, Reward, and Komeen). The results of the first ANOVA were that there was no significant difference in fishs abundance between control and treatment samples when all treatments were lumped together although control samples averaged somewhat higher catches than treatment samples. A second analysis was an analysis of covariance (ANCOVA) with fixed factor Treatment (control, mechanical, Reward, Komeen) and covariate Datecode (sample date coded from 1-9). The mean catch of fish at the Komeen area was noticeably less than at the control, mechanical, and Reward areas but not statistically different due to high variability among samples. The mean catch declined in the order control>mechanical>Reward>Komeen, but this trend was not statistically significant ($p = 0.29$). There was a large catch of inland silversides on July 15 at the Reward site prior to the second application of Reward. *Egeria* abundance was low from the beginning of June throughout the area and did not reappear in the study areas until the end of October at the mechanical treatment and control areas.

Sandmound Slough was sampled seven times with pop-nets: May 2, May 11, May 22, June 17, July 17, August 7, and October 21. The initial survey was done before any chemical treatments were applied. Survey areas included four different treatments: control, mechanical harvest, Reward, and Komeen. A 2-way analysis of variance (ANOVA) was run with factors date and treatment. Separate 1-way ANOVA's were also run with the same factors individually. Date had 7 levels and treatment had 4. The raw data of numbers of fish per square meter ranging from 0 to 30 were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. The results of the 1-way ANOVA were that there was a significant difference in fish abundance between sampling dates ($p < 0.001$). Catches were high in August and they were low in October. There appeared to be an increasing seasonal trend of bluegill abundance during spring and summer with a decline in autumn. There was no difference in mean catch between treatments ($p = 0.19$). The catches in the mechanical harvest area were somewhat lower than in the control or chemical treatment area, but not statistically significant.

White Slough was sampled seven times with pop-nets: May 13, May 21, June 12, July 16, August 12, October 7, and October 21. The initial survey was done before any

chemical treatments were applied. Survey areas included four different treatments: control, mechanical harvest, Reward, and Komeen. A 2-way analysis of variance (ANOVA) was run with factors date and treatment. Date had 7 levels and treatment had 4. The raw data of numbers of fish per square meter ranging from 0 to 138 were log-transformed prior to analysis. The response variable tested was ln(n + 1) where ln is the natural log and n = the catch of fish per pop-net sample. Each pop-net captures a column of water 1 square meter in area. The results of the ANOVA were that there was not a significant difference in fish abundance between sampling dates ($p = 0.405$) and there was no difference in mean catch between treatments ($p = 0.333$). There was an apparent seasonal peak of abundance of fish from late May through early August(Fig.1). There was an apparent trend in abundance with treatment decreasing from control > Reward, > mechanical > Komeen, but the individual differences were not statistically significant (Fig.2). The mean abundance of fish at control samples was larger than the mean of all the treatments, but not statistically different ($p = 0.227$).

Figure 1. Mean abundance of fish collected in pop-nets at White Slough on May 13, May 21, June 12, July 16, August 12, October 7, and October 21.



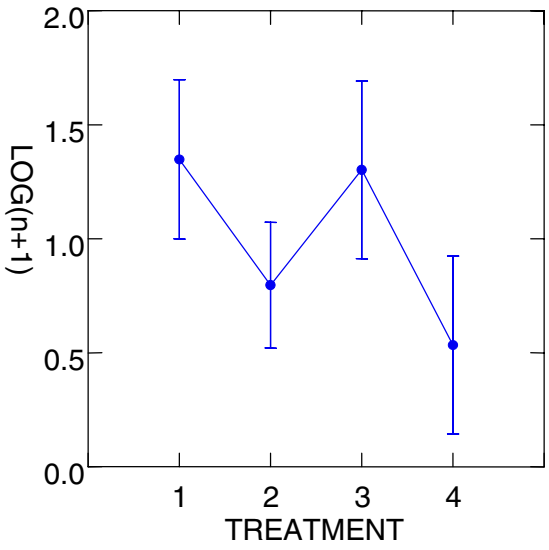


Figure 2. Mean abundance of fishes collected in pop-nets at White Slough in 1998 by treatment type: 1= control, 2=mechanical, 3= reward, 4=komeen.

Summary of Results of Pop-net Sampling

The species collected were typical non-native residents of the delta. Small individuals of bluegill sunfish, largemouth bass, threadfin shad, and inland silversides dominated the catches. No threatened or endangered species were collected. Some apparent differences in mean abundance of fish were noted among treatment types and sampling dates. Figure 1 and Figure 2 are representative of plots of abundance by date or treatment at all sample locations. Fish abundance was often slightly higher at control locations than at treatment locations. Fish abundance was generally higher in mid-summer and then declined in autumn. These differences were generally not statistically significant but no evidence of a large negative impact on abundance was noted.

Literature Cited

Dewey, M.R., L.E. Holland-Bartels, and S.J. Zigler. 1989. Comparison of fish catches with buoyant pop nets and seines in vegetated and nonvegetated habitats. N.Am. J. Fish. Mgmnt. 9:249-253.

Espegren, G.D., and E.P. Bergersen. 1990. Quantitative sampling of fish populations with a mobile rising net. N. Am. J. Fish. Mgmnt. 10:469-478.

Foschi, P. 1989. (Aerial photographic survey of *Egeria densa*)

Obrebski, S., T. Irwin, and J. Pearson. 1998. Effects of control methods on the *Egeria densa* community. Draft report prepared for DBW.