

September 10, 2010

Stephen Phillips

Pacific States Marine Fisheries Commission

205 SE Spokane Street, Suite 100, Portland, Oregon 97202

Dear Mr. Phillips,

Based on your requirement, this report includes Experiments 2 & 3 we did from April to August 2010.

Experiment 2: Evaluation of the time needed to reach and sustain the lethal temperatures in the inaccessible areas

The gimbal unit was evaluated by using hot water with different temperatures in spring (Air temperature 52-55°F) (Table 1). The time required to reach the lethal temperature was affected by the ambient air temperature significantly. In the experimental conditions, the times needed to reach lethal temperatures of 176, 158, 140, 130, 122 and 104 (°F) were 1'34", 1'46", 1'20", 1'12", 1'48", and 1'05", respectively.

From reaching the lethal temperature to kill quagga mussels, the total times needed will be 1'39", 1'51", 1'25", 1'22", 2'08", 1'45" respectively, for temperatures of 176, 158, 140, 130, 122, and 104 (°F) (Table 2). It is recommended that 140°F will be used for boat decontamination as it needs 5" to kill quagga mussels under this temperature, the same duration as temperature 158 and 176 °F. Therefore, the recommended temperature and

duration for decontaminating gimbal area around 68°F ambient temperature is 140°F with minimum 1'25" (Table 2).

Table 1 Time needed to reach lethal temperature for the gimbal unit

Experimental Hot Water Temp		Air Temp		Target Temp		Replicate	Time (min:sec)	Average Time (min:sec)
(°F)	(°C)	(°F)	(°C)	(°F)	(°C)			
176	80	67	19.4	176	80	1	1:39	1:34
176	80	67	19.4	176	80	2	1:22	
176	80	67	19.4	176	80	3	1:41	
158	70	63	17.2	158	70	1	1:50	1:46
158	70	65	18.3	158	70	2	1:38	
158	70	66	18.9	158	70	3	1:49	
140	60	68	20.0	140	60	1	1:11	1:20
140	60	68	20.0	140	60	2	1:34	
140	60	68	20.0	140	60	3	1:14	
130	54	68	20.0	130	54	1	1:00	1:12
130	54	69	20.6	130	54	2	1:22	
130	54	69	20.6	130	54	3	1:15	
122	50	69	20.6	122	50	1	1:46	1:48
122	50	70	21.1	122	50	2	1:44	
122	50	70	21.1	122	50	3	1:54	
104	40	69	20.6	104	40	1	1:06	1:05
104	40	69	20.6	104	40	2	1:03	
104	40	69	20.6	104	40	3	1:04	

Table 2 Total time needed from reaching to sustaining the lethal temperature for killing quagga mussels in the gimbal unit

Hot Water Temp		Air Temp		Time to Reach	Time to Kill	Total Time Needed
(°F)	(°C)	(°F)	(°C)	Targeted Temp	Quagga Mussels*	for Boad Decontamination
176	80	67	19.4	1:34	5 s	1:39
158	70	65	18	1:46	5 s	1:51
140	60	68	20.0	1:20	5 s	1:25
130	54	69	20	1:12	10 s	1:22
122	50	70	21	1:48	20 s	2:08
104	40	69	20.6	1:05	40 s	1:45

* Results from Experiment 1

Experiment 3: Field test on the time required for contact temperature in the special areas to reach and sustain the lethal temperatures

Special areas including bait wells, live wells and washdown system were evaluated using hot water with different temperatures in April (Table 3). The ambient temperature could affect the experimental results. The data reported below were for the experimental conditions in Lake Mead (Table 3). For live wells, the times needed to reach lethal temperatures of 130, 122 and 104 (°F) were 3'15", 3'12" and 3'09", respectively. For washdown system, the times needed to reach lethal temperatures of 130, 122 and 104 (°F) were 1'25", 1'05" and 1'11", respectively. When looking at these numbers here, it must be taken into consideration the variables in the locations of the bait and live well in the boats and the length and size of the line to and from them.

The total times needed to reach and sustain the lethal temperature between 122 °F and 130 °F in these three special areas were not significantly different (T-test, $P > 0.05$, Table 4). Therefore, it is recommended that 122°F will be used for boat decontamination to save energy and better protect these special areas. Under similar experimental air

temperatures, the recommended duration for decontaminating bait wells, live wells and washdown system is 58", 3'32" and 1'25", respectively.

Table 3 Time needed to reach lethal temperature for bait wells, live wells and washdown system

Special Area	Experimental Hot Water Temp		Air Temp		Target Temp		Replicate	Time (min: sec)	Average Time (min:sec)
	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)			
Bait Wells	130	54	52	11.1	130	54	1	0:41	0:41
	130	54	54	12.2	130	54	2	0:43	
	130	54	55	12.8	130	54	3	0:39	
	122	50	51	10.6	122	50	1	0:44	0:38
	122	50	52	11.1	122	50	2	0:32	
	122	50	52	11.1	122	50	3	0:36	
	104	40	50	10.0	104	40	1	0:37	0:37
	104	40	50	10.0	104	40	2	0:38	
	104	40	50	10.0	104	40	3	0:36	
Live Wells	130	54	65	18.3	130	54	1	3:15	3:15
	122	50	65	18.3	122	50	1	3:12	3:12
	104	40	67	19.4	104	40	1	3:09	3:09
Washdown System	130	54	65	18.3	130	54	1	1:50	1:25
	130	54	65	18.3	130	54	2	1:15	
	130	54	65	18.3	130	54	3	1:10	
	122	50	64	17.8	122	50	1	1:01	1:05
	122	50	64	17.8	122	50	2	1:08	
	122	50	65	18.3	122	50	3	1:05	
	104	40	61	16.1	104	40	1	1:10	1:11
	104	40	63	17.2	104	40	2	1:13	
	104	40	63	17.2	104	40	3	1:08	

Table 4 Total time needed from reaching to sustaining the lethal temperature for killing quagga mussels in special areas

Special Areas	Hot Water Temp		Air Temp		Time to Reach Targeted Temp (min:sec)	Time to Kill Quagga Mussels*	Total Time Needed for Boat Decontamination (min:sec)
	(°F)	(°C)	(°F)	(°C)			
Bait Wells	130	54	54	19	0:41	10 s	0:51
	122	50	52	17	0:38	20 s	0:58
	104	40	50	20	0:37	40 s	1:17
Live Wells	130	54	65	18	3:15	10 s	3:25
	122	50	65	18	3:12	20 s	3:32
	104	40	67	19	3:09	40 s	3:49
Washdown System	130	54	65	18	1:25	10 s	1:35
	122	50	64	18	1:05	20 s	1:25
	104	40	62	17	1:11	40 s	1:51

* Results from Experiment 1

In summer time, bait wells and live wells were evaluated using hot water (Table 5). For bait wells, the times need to reach lethal temperatures of 130 or 122 (°F) were 34". The corresponding kill times are going to be 44" and 54" respectively (Table 5). For live wells, the times needed to reach lethal temperatures of 130 °F were 1'38".

Table 5 Total time needed from reaching to sustaining the lethal temperature for killing quagga mussels in special areas in summer time

Special Area	Experimental Hot Water Temp		Air Temp		Target Temp		Replicate	Time (min: sec)	Average Time (min:sec)	Time to Kill Quagga Mussels*	Total Time Needed for Boat Decontamination (min:sec)
	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)					
Bait Wells	130	54	98	36.7	130	54	1	0:33	0:34	10 s	0:44
	130	54	98	36.7	130	54	2	0:34			
	130	54	98	36.7	130	54	3	0:34			
	122	50	98	36.7	122	50	1	0:34	0:34	20 s	0:54
	122	50	98	36.7	122	50	2	0:34			
	Live Wells	130	54	98	36.7	130	54	1	1:51	1:38	10 s
130		54	98	36.7	130	54	2	1:42			
130		54	98	36.7	130	54	3	1:21			

* Results from Experiment 1

Unfortunately, we could not find boaters who were willing to allow us to sue their boat in the summer time to conduct Experiment 2 (Gimbal Unit). With new equipment just developed for temperature control, we can now use other marinas. This will allow us to use portable wash unit at other marinas instead of being tied to Callville Marina. This is giving us a greater number of, hopefully, available boats. With this ability, we believe we will be able to do the tests within the next two weeks. Having that said, we probably don't need to do this experiment. For boat decontamination program, it is better to have one standard to kill mussels whether it is winter time or summer time. As it took significant shorter times (T-test, $P < 0.05$ in case of Bait Wells at 130°F) to reach the lethal temperature in the summer (see Experiment 3 results on Bait Wells in Tables 5 and 6), to have a higher standard, we need a longer time (higher standard) for boat decontamination.

Table 6 Comparison of time needed to reach 130°F in the Bait Wells and Live Wells under different air temperatures

Special Area	Experimental Hot Water Temp (°F)	Air Temp (°F)	Target Temp (°F)	Replicate	Average Time (min:sec)
Bait Wells	130	54	130	N = 3	0:41
	130	98	130	N = 3	0:38
Live Wells	130	65	130	N = 1	3:15
	130	98	130	N = 3	1:38

We are planning to do Experiment 4 (validation experiment) in the coming two weeks (Summer Validation) after we find suitable boats and in December (Winter Validation, because of weather conditions, it is too warm to conduct winter validation experiment in the past April and May).

If you need more information, please let us know.

Sincerely,

David Wong

Shawn Gerstenberger

Wen Baldwin

Emily Austin