6.0 EFFECTS OF THE ACTION ON LISTED FISH

6.1 General

Water development and uses, along with other human activities; have probably been affecting the endangered fish species since the end of the 19^{th} century. Early water uses greatly depleted base flows and water quality problems probably peaked early in the 20^{th} century as new irrigation lands were developed, pollution from mining was high, and grazing and other land uses were largely unregulated (see Section 3.4.3 for more discussion).

6.2 Methodology

Existing information on potentially affected species was reviewed and appropriate information summarized for this report. Alternative Aspinall Unit operation modeling runs were conducted and reviewed with the Fish and Wildlife Service as part of informal Section 7 consultation on the effects of new operations on the endangered fish. During this consultation, peak flows, flow duration, flows downstream from the Redlands Diversion, and base flows were considered as well as concerns with factors such as potential flooding in the Delta area. Information on hydrology modeling is found in Section 3.4 and Attachment 12 and in the draft EIS for Aspinall reoperations.

Changes in habitat conditions, such as channel morphology and backwater availability related to flow changes, were then considered along with effects on water quality, non-native species, and other factors. Flows under the proposed alternative were also compared to the goals of the Flow Recommendations.
This section includes an analysis of the direct and indirect effects of the proposed action, its interrelated and interdependent activities on species and critical habitat. Cumulative effects are considered by assessing the effects of future actions reasonably likely to occur in the area.

While construction of the Aspinall Unit and other public and private water projects are not addressed in this PBA, the ongoing effects of operating the Aspinall Unit and other water uses are. In regard to endangered fish, these ongoing effects are reflected in the baseline and include habitat changes related to reducing spring peaks in critical habitat and increasing base flows, cooling summer water temperatures, and reducing concentrations of water pollutants by reservoir releases in low water periods.

The proposed action would have beneficial effects on the four listed Colorado River fishes and their critical habitat within the action area when compared to the baseline. Benefits result from the increased frequency, magnitude, and duration of spring peak flows and protection of base flows. The flow changes will assist in improving and maintaining habitat conditions for spawning and recruitment and for maintenance of adult pikeminnow and razorback sucker habitat. For Colorado pikeminnow (and probably other endangered fish), Osmundson and Burnham (1998) reported that the success of recovery efforts will largely depend on providing environmental conditions that increase reproductive success and survival of early life stages. In general, the implementation of a flow regime that more closely resembles a natural flow regime of the river will provide benefits to the endangered fish and their habitat.

6.3 Flow and Habitat Effects

Table 11 and Figure 7 summarize a comparison of baseline and proposed action peak flows and Table 12 presents a comparison of the frequency of selected flows. Detailed information is contained in Attachment 8.1 and 8.2. It should be noted that mean daily peak flows are presented; instantaneous peaks would be higher. As discussed previously in this assessment, flows adequate to move sediment through the Gunnison River system are crucial to maintaining and improving critical habitat for the listed fishes. Reaching flows that are half bankfull or bankfull is considered key in the sediment movement. Goals of 8,070 and 14,350 cfs were established in the Flow Recommendations. At a flow of 8,070 cfs one-half (27) of the river cross sections identified by Pitlick et al. (1999) reach half bankfull (initial motion) and at 14,350 cfs one-half of the river cross sections reach bankfull (significant motion). As can be seen in Tables 12 and 13 and Attachment 8.4-8.5, the number of days that flow reaches these thresholds increases as well as the frequency of the years they are reached.

Table 11. Summary of peak flows (mean daily) at Whitewater gage for study period, baseline and proposed action.

	Baseline	Proposed action
Mean May peak flow (cfs)	8,551	10,124
Mean June-July peak flow (cfs)	7,448	8,310

Table 12. Percentage of years in study period when selected flow levels are exceeded at the Whitewater gage during the spring runoff. Half bankfull and bankfull highlighted.

Flow (cfs)	Percentage of years selected flow exceeded	
	Baseline	Proposed action
6,000	61	77
7,000	55	77
8,070	52	61
9,000	45	52
10,000	35	48
11,000	29	45
12,000	26	35
13,000	26	29
14,000	19	26
14,350	19	26

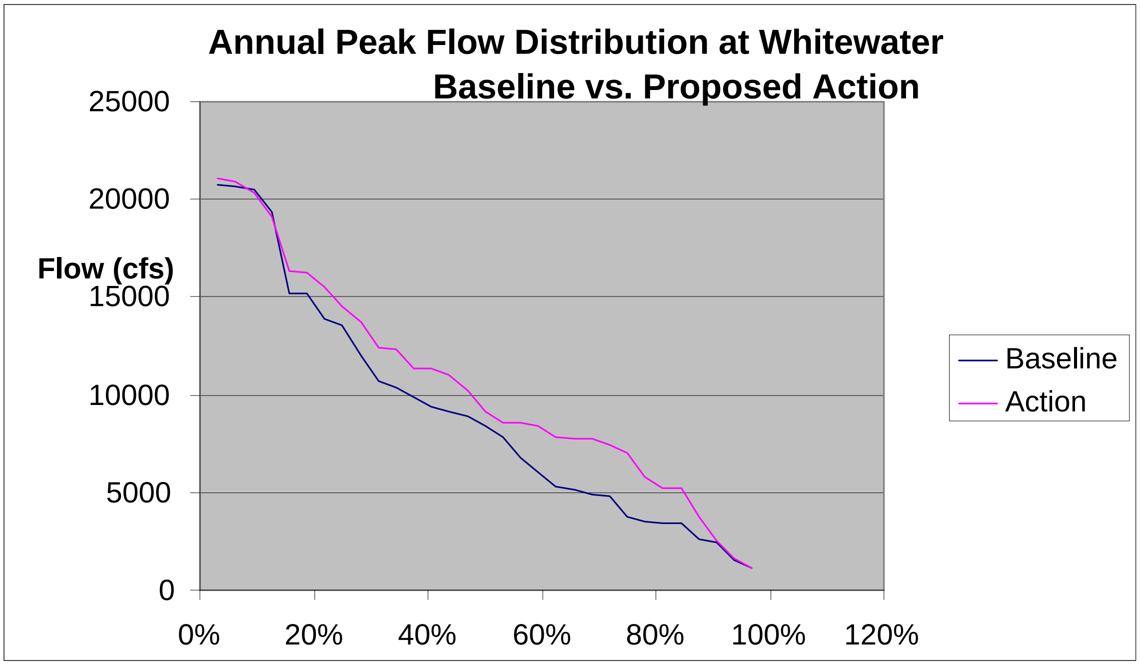


Figure 7. Expected frequencies of peak flows at Whitewater Gage under Baseline and proposed action conditions.

Under the proposed action, peak flows would be greater and occur more frequently than baseline peak flows. Proposed Action mean peak flows in May would be about 10,124 cfs, or 18% greater than the baseline peak (8,551 cfs). This average peak magnitude is more approximate of natural conditions, indicating a return to less regulated flow conditions. Peak flows equal to or greater than initial motion threshold flows (8,070 cfs; Pitlick et al. 1999) should occur during 19% more years under the proposed action than under the baseline, and flows equal to or greater than significant motion threshold flows (14,350 cfs) should occur during 33% more years than under baseline condition.

It should be noted that flows above and below target flows also provide benefits to habitat (Table 6 and Attachment 4). Table 13 shows the percentage of transects (Pitlick et al. 1999) where half bankfull and bankfull flow elevations were attained over a range of discharge and the relative gain in frequency of days at these flows under baseline and proposed action. The greatest gain (24%) occurs in average number of days at or above 10,000 cfs, at which time 80% of the transects are at half bankfull flow elevations. However, average number of days of flows at 6,000 and 7,000 also increases by 6% and 12%, at which level 20 to 35% of all transects are at half bankfull flows, indicating that finer bed materials are mobilized in many areas and gravel embededness is reduced.

Table 13. Percentage of study transects used by Pitlick et al. (1999) at which half bankfull and bankfull flows are attained at a given river flow and the average number of days (and % difference) each flow is met or exceeded within a given year under baseline flows and the proposed action.

	Pitlick transects		Duration of flow		
Flow (cfs)	% at half bankfull	% at bankfull	Days, under baseline	Days, under proposed action	% Difference
6,000	19	0	28.0	29.6	+6
7,000	33	0	21.6	24.2	+12
8,000	46	2	16.5	17.6	+7
10,000	81	6	8.8	10.9	+24
14,000	100	46	3.1	3.5	+13

Flows in the range of 4,400 to 5,300 cfs also have the capacity to mobilize sand and finer sediments, which should function to keep spawning substrates relatively clean (Pitlick et al. 2007). Frequency of years flows reach near bankfull elevations (14,350 cfs) is 33% greater under the proposed action than baseline conditions, with nearly half of all transects subject to significant (bankfull) bed load motion. Additional information on an annual basis is included in Attachment 8.3.

The increase in frequency and duration of initial and significant motion (half- and bankfull flows) under the proposed action would help maintain the interstitial spaces in gravel and cobble bars that provide spawning habitat, habitat for larval fish immediately after hatching, and for macroinvertebrates which are important for the food web of the endangered fish. Increases in significant motion conditions shift cobble and gravel bars, scour vegetation, and help maintain side channels which overall help maintain or improve channel complexity of benefit to the fish.

Flow regimes under the proposed action would result in increased interannual variability. In particular, during moderately dry years, spring releases would be made in proportion to inflow at Blue Mesa (381,000 to 516,000 af), which adds more certainty that the Gunnison River at Whitewater would vary between 2,600 to 8,070 cfs from one year to the next (Table 3). Similar proportionality would be seen during average wet years. In contrast, under baseline flows, such proportionality would be maintained only if excess water was available. Increased variability should support in-channel processes that help maintain habitat for the endangered fish, particularly during moderately dry years when half bankfull conditions could be attained at a greater percentage of river reaches than under baseline flows.

The potential relative difference in fine sediment movement when baseline flows and proposed action flows are compared can be seen in the differences in half and bankfull flows. More fine sediment would be mobilized under proposed action flows than under the baseline. Higher flows also have a disproportionate increase in sediment movement compared to lower flows. Thus, the net result of increased frequency of high flows would also include a greater active channel area under the proposed action.

The proposed action will meet the duration targets of the flow recommendations more frequently than baseline flows. Thus the proposed action more closely approximates recommendations for flow durations made by Pitlick et al. (1999; summarized in McAda 2003). The frequencies for which the two alternatives meet the half and bankfull maintenance and improvement flows is shown in Table 14. In most flow categories the proposed action consistently would provide more days at the described flows than the baseline flow. Thus the proposed action would more closely approximate recommendations.

Table 14. Frequency (% of recommended days for meeting or exceeding flow level) at which baseline flows and proposed action flows meet flow recommendations for half and bankfull flows for channel maintenance and improvement. Higher frequencies under the proposed action are highlighted in green.

	Baseline flows				Proposed action			
	Maintenance flows		Improvement flows		Maintenance flows		Improvement flows	
Category	% 1/2 bankfull	% bankfull	% 1/2 bankfull	% bankfull	% 1/2 bankfull	% bankfull	% 1/2 bankfull	% bankfull
Dry	na	na	Na	na	na	na	na	na
Mod. Dry	na	Na	0%	na	na	na	0	na
Avg. dry	126%	Na	84%	na	130%	na	87%	na
Avg wet.	50%	0%	40%	0%	100%	0	70%	0
Mod wet	84%	41%	56%	20%	91%	52%	60%	26
wet	109%	170%	66%	108%	112%	166%	67%	100

Due to operational limitations including flood control, extremely high flows (> 15,000 cfs) would not be significantly increased by the proposed action and thus flows that significantly modify channel conditions and create new habitat would not increase. These flows would probably occur in the future due to extreme hydrologic conditions or forecast errors but would not differ significantly from baseline conditions.

Floodplain and backwater habitat would be improved under the proposed action. Overall, inundation of floodplains tends to increase significantly between 5,000 cfs and 14,000 cfs, and frequency and duration of spring peak flows in this range are greater under the proposed action than under baseline flow conditions (Table 15). At 5,000-6,000 cfs small floodplain wetlands begin to be inundated in the area immediately downstream of Delta (Johnson Boys' Slough, others), and the Craig gravel pit pond near Whitewater connects to the main channel Gunnison River (Reclamation 2006b). Flooded acreage at the Escalante State Wildlife Area increases with Gunnison River flows such that 80, 140 and 200 acres become inundated at 8,000, 10,000 and 14,000 cfs, respectively (Valdez and Nelson 2006; Burdick and Irving 1995). Wetlands near Confluence Park at Delta flood at about 9,000 to 10,000 cfs. Additional information on an annual basis is found in Attachment 8.3.

Table 15. Floodplain flows-Baseline and Proposed Action for period of study.

	Days >5,000 cfs (Craig, Johnson Boys' Slough)		Days > 8,000 cfs (Escalante 80 acs)		Days >10,000 cfs (Escalante 100 acs, Confluence Park)		Days > 14,000 cfs (Escalante 200 acs)	
	Baseline	Action	Baseline	Action	Baseline	Action	Baseline	Action
Avg. days/yr	35.4	36.3	16.5	17.6	8.8	10.9	3.1	3.5
% of yrs	68	87	52	61	35	48	19	26

In most instances, the proposed action would assure flows to operate the Redlands Fish Ladder from April through September and the Redlands Fish Screen as needed. Migration flows of 300 cfs are recommended downstream from Redlands. Due to shifts in water release volumes toward the spring peak period, the proposed action would result in an average of 32.2 days annually below that flow level compared to 22.3 days under the baseline during April-September. Flows less than 100 cfs would increase by an average of 1.2 days annually during the same period under the proposed action (See Attachment 10).

Changes in the mainstem of the Colorado River have not been analyzed in detail for this assessment. In general spring flows would be increased in magnitude and/or duration downstream from the Gunnison confluence. The greatest increase would be seen in moderately wet and moderately dry years, during which over 1,500-2,000 cfs would be added to the flow of the Colorado River. About 2,000 cfs and 1,000 cfs would be added in average dry and average wet years. Dry and wet year additions would generally be negligible. In any case, benefits to the Colorado River due to increased flows from the Gunnison River would probably be maximized during years in which coordinated reservoir operations in the upper Colorado River basin are implemented. Since 2000, water – from releases from upstream Colorado River reservoirs, coordinated reservoir operations, and irrigation efficiency improvements -- averaging 48,000 af per year, has proved endangered fish habitat (Recovery Program 2008). Attachment 9 summarizes peak and average monthly flow changes for the study period below the Gunnison confluence and information is summarized in Table 16.

Table 16. Approximate average contribution of Gunnison River (cfs) to Colorado River during May spring peak during study period.

	Baseline Conditions	Proposed Action
Dry Year	2,072	2,120
Moderately Dry Year	4,229	6,864
Average Dry Year	7,807	10,445
Average Wet Year	11,048	13,028
Moderately Wet Year	12,354	15,070
Wet Year	19,052	19,053

This PBA assumes that similar beneficial effects of the proposed action on the Gunnison River ecosystem and endangered fish will be accrued to some extent in the Colorado River ecosystem. This assumption should be considered an uncertainty that should be evaluated by the Recovery Program.

Reclamation (Boyer 2004) developed a model to depict reservoir release water temperatures under the Flow Recommendations. This model showed that overall, release water temperatures would be similar under baseline and proposed action conditions. In years with increased spring flows, warming of the main channel of the Gunnison River would be delayed. If peak flows remain at or above 3,000 cfs during June, favorable Colorado pikeminnow spawning temperatures (≥18 °C) would occur in the Whitewater area but not likely in the Delta area (Figure 7). Favorable temperatures would occur in both areas during July at flows of about 2,000 to 3,000, however. The trade-off between high flows for channel maintenance and spawning temperature regime in the Gunnison River is thus an uncertainty that may need to be evaluated by the Recovery Program. The temperature of the Colorado River is not expected to change significantly in relation to the proposed action (McAda 2003).

There will be effects on water quality. The Aspinall Unit has tended to improve water quality conditions in critical habitat by reducing extremely low flow months when pollutants are concentrated. From August thru March, the Unit generally has more than doubled pre-Aspinall Unit flows. At lower flows, seen in some months under the proposed action, the dilution effects of Aspinall releases are reduced. However, base flows should be maintained adequately to provide dilution, and provision of base flows will reduce periods of extremely low flows. Operations will continue to eliminate periods of extreme low flows seen prior to construction of the Unit. Table 17 shows modeled information on average monthly flows at the Whitewater gage under the proposed action and Table 18 summarizes a comparison of average monthly flows for the baseline and proposed action. From a cumulative impact standpoint, ongoing projects in the basin to reduce salinity and selenium loading are expected to continue and this should help maintain or improve water quality

The proposed action will affect selenium levels in the Gunnison River. Under the Flow Recommendations, higher May and June flows will tend to increase dilution of pollutants in the river while lower flows in other months will tend to increase concentrations of pollutants. Increasing releases to meet base flows will tend to increase dilution of pollutants in moderately dry periods and thus maximum selenium levels should be reduced. Table 19 summarizes projected effects of the proposed action compared to baseline conditions and Table 20 compares baseline to proposed action with respect to number of days per year the state standard for selenium is exceeded at Whitewater. Figure 8 displays baseline and proposed action for average and maximum monthly selenium levels. More detailed information is found in Attachment 6.

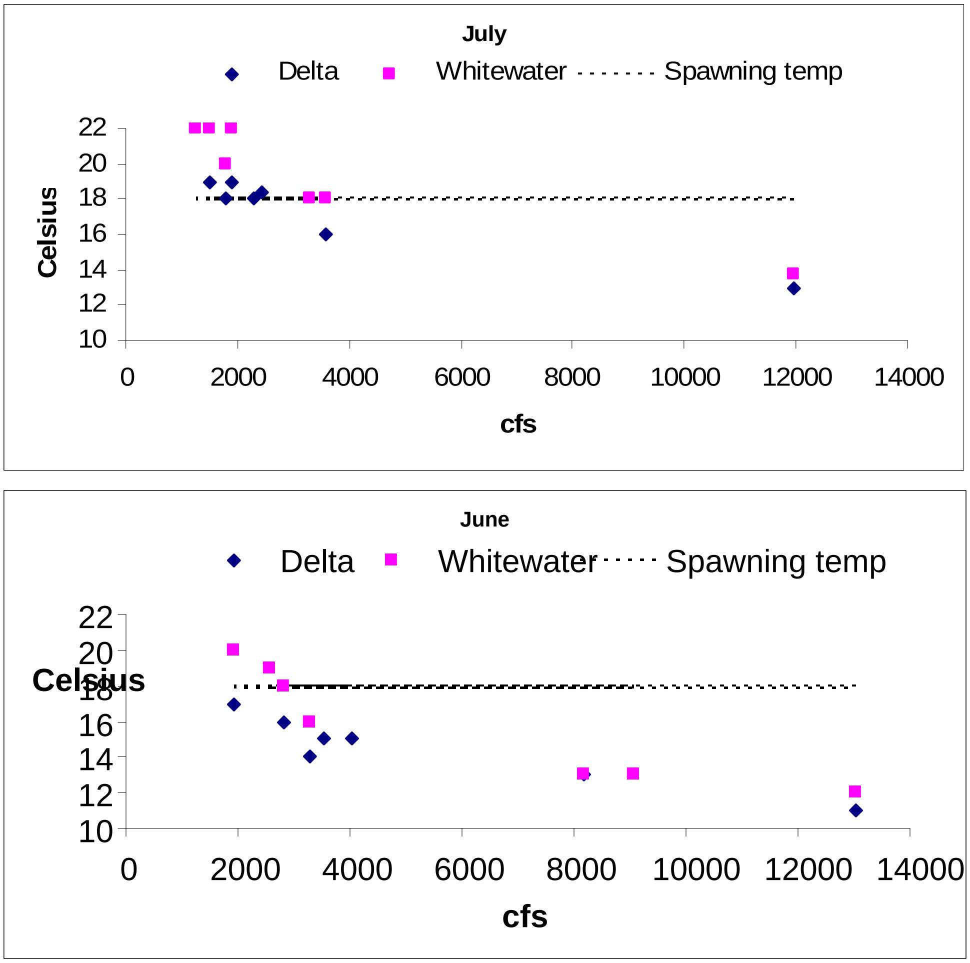


Figure 7. Gunnison River temperatures at Delta and Whitewater during June and July in relation to spawning temperature threshold for Colorado pikeminnow. Data were collected during 1992-2000 (McAda 2003).

6.4 Other Effects

The proposed action includes continuation of existing water uses and implementation of the Recovery Program and conservation measures. Existing water uses are included in the baseline and effects discussed include their continued operation. The continuation of the Recovery Program will support habitat restoration, monitoring, fish passage and screening, stocking, and better control of non-native fish. All of these actions are anticipated to have a positive effect on endangered fish populations.

Table 17. River flows (average monthly cfs), Gunnison River at Whitewater, for proposed action.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Peak daily mean
1975	1023	1022	1065	2422	6586	6328	3231	1929	1939	1866	1538	1489	12296
1976	1139	1189	1082	1620	5183	2293	1292	1025	1243	1395	905	807	8386
1977	789	767	757	785	846	879	939	794	795	902	873	778	1194
1978	764	748	858	3130	7000	7181	1696	1054	1162	1034	1098	1110	11364
1979	1046	2652	1906	4091	8976	9062	3043	1486	1207	1239	1163	1038	16261
1980	1033	2256	1576	3537	10244	7433	2319	1471	1286	1105	1190	1328	16326
1981	964	786	852	1304	1539	1423	1057	925	1179	1455	1082	826	3771
1982	1009	1144	1092	3277	7459	5157	2276	1938	2650	2604	2370	2299	11023
1983	1347	1277	1782	2797	8597	14045	7637	3031	2204	2445	2238	2531	17306
1984	2845	2629	2578	4918	13735	13699	6720	2774	2500	2997	2953	3179	19053
1985	2793	2241	2012	6587	10988	9986	2993	1608	2295	2680	2508	2600	15503
1986	2418	1655	3793	5421	8624	8032	3596	1947	2731	3335	3186	3250	13727
1987	1976	1795	2006	5171	6982	5710	1986	2032	2319	1809	1527	1516	10191
1988	1083	1196	1165	2267	2667	1849	1361	1046	1258	1030	901	818	5814
1989	851	1097	1614	2554	2508	1535	1331	1058	1117	1140	969	891	5243
1990	789	750	799	1006	1640	1584	1166	1014	1146	1352	962	883	2566
1991	813	781	864	1845	5278	4097	1904	1599	1994	1880	1630	1733	8593
1992	1124	1033	1138	3215	4130	2746	2073	1550	1631	1830	1565	1229	8583
1993	1050	1205	2843	4163	12387	10535	3747	2207	2345	2630	2215	1937	21040
1994	1328	1215	1489	2153	4503	2229	1550	1131	1409	1639	1428	1351	7755
1995	1044	963	2611	3348	9386	13708	12559	3024	2691	2767	2804	2729	19125
1996	1663	2156	2752	3485	7097	3507	1835	1342	1862	1781	1781	1856	12412
1997	2687	2716	2745	4364	9213	8632	3041	2405	3223	3177	2812	2716	14530
1998	1575	1461	2134	3578	7018	3129	2293	1519	1875	2038	1829	1718	9158
1999	1080	1085	1362	1374	4454	4381	2392	2576	2710	2352	2094	2043	7783
2000	1380	1393	1537	2719	3837	2190	1329	1066	1286	1417	1128	898	7840
2001	808	772	923	1487	4292	1711	1800	1323	1617	1496	1181	1112	7439
2002	969	823	840	1042	917	876	892	844	1094	1153	882	765	1170
2003	752	757	801	1181	3457	1825	1046	1060	1225	1020	858	770	7033
2004	779	765	1115	2038	2868	1313	1036	1060	1321	1304	980	889	5207
2005	943	898	1002	3958	7113	4503	2173	1435	1654	1923	1499	1186	11372
Mean study period	1286	1330	1584	2930	6114	5212	2655	1589	1773	1832	1618	1557	
Mean below average years	1017	1006	1175	1924	3573	2176	1494	1244	1448	1463	1212	1112	
Mean above average years	1576	1690	2041	4045	8959	8501	3924	1979	2138	2226	2059	2051	

Table 18. River flows (average monthly cfs), Gunnison River at Whitewater, for proposed action and baseline for study period.

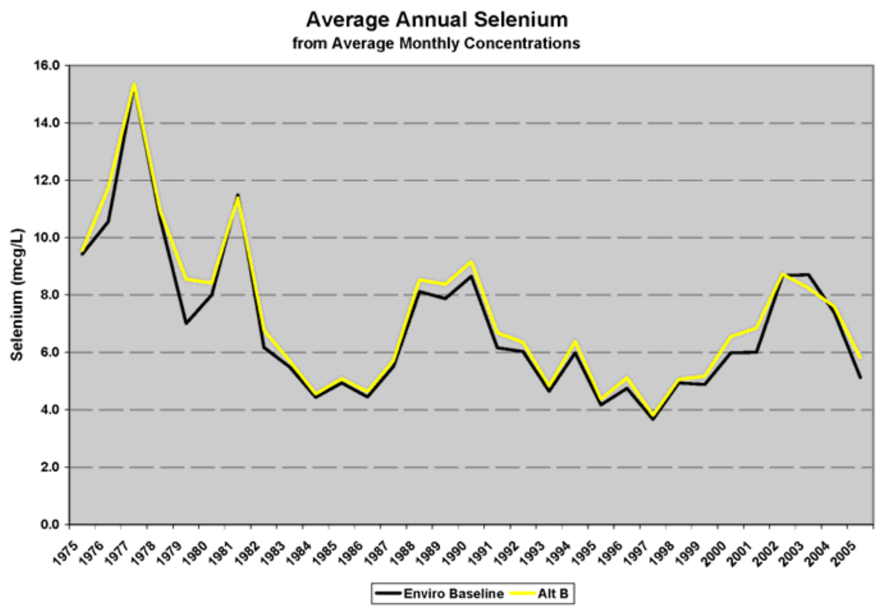
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline	1377	1408	1711	3122	5718	4993	2820	1641	1862	1895	1697	1650
Proposed Action	1286	1330	1584	2930	6114	5212	2655	1589	1773	1832	1618	1557

Table 19 Estimated selenium concentrations (mcg/L) at Whitewater gage under Baseline and under Proposed Action (proposed action shown in bold)

	Average annual concentration	Maximum monthly concentration	Minimum monthly concentration
1975	9.5 **9.5**	16.8 **14.1**	3.6 **4.2**
1976	10.7 **11.7**	16.0 **17.3**	4.8 **4.1**
1977	15.4 **15.4**	18.9 **19.1**	12.0 **12.5**
1978	10.7 **10.9**	17.9 **15.5**	3.3 **3.3**
1979	7.0 **8.5**	10.4 **13.1**	2.6 **2.8**
1980	8.0 **8.4**	15.1 **14.3**	2.4 **2.4**
1981	11.5 **11.4**	17.2 **14.2**	7.4 **7.7**
1982	6.3 **6.8**	9.9 **10.9**	2.7 **2.7**
1983	5.5 **5.7**	7.9 **8.5**	2.1 **2.1**
1984	4.4 **4.5**	6.6 **6.8**	1.9 **1.9**
1985	4.9 **5.1**	8.3 **8.3**	2.0 **2.0**
1986	4.4 **4.6**	6.8 **7.1**	2.2 **2.2**
1987	5.5 **5.7**	8.1 **8.5**	2.4 **2.4**
1988	8.2 **8.5**	11.7 **12.2**	4.2 **4.4**
1989	7.9 **8.4**	11.0 **11.4**	3.9 **4.0**
1990	8.8 **9.2**	11.2 **11.2**	5.2 **5.4**
1991	6.3 **6.7**	9.3 **10.3**	2.8 **2.8**
1992	6.0 **6.3**	7.8 **8.2**	3.0 **3.0**
1993	4.7 **4.8**	8.3 **8.2**	1.6 **1.7**
1994	6.0 **6.4**	8.4 **9.1**	3.1 **2.9**
1995	4.2 **4.4**	7.7 **8.0**	1.6 **1.6**
1996	4.7 **5.1**	6.9 **7.8**	2.2 **2.1**
1997	3.7 **3.8**	5.1 **5.3**	1.8 **1.8**
1998	4.9 **5.1**	6.8 **7.0**	1.9 **2.0**
1999	4.9 **5.2**	7.2 **7.5**	2.8 **2.7**
2000	6.0 **6.5**	8.5 **9.5**	3.2 **3.1**
2001	6.1 **6.8**	7.7 **9.2**	3.1 **2.7**
2002	8.7 **8.7**	10.6 **10.7**	6.**0** **6.4**
2003	8.6 **8.2**	11.7 **10.8**	3.5 **3.5**
2004	7.4 **7.6**	10.0 **9.7**	3.6 **3.4**
2005	5.3 **5.8**	7.8 **8.1**	1.8 **2.0**

Table 20. Number of days selenium concentration exceeds 4.6 ppb at Whitewater gage.

Year	Baseline	Proposed action
1975	311	325
1976	356	346
1977	365	365
1978	280	294
1979	275	276
1980	286	290
1981	363	363
1982	281	291
1983	254	256
1984	194	202
1985	233	257
1986	205	219
1987	259	261
1988	327	330
1989	320	316
1990	353	356
1991	289	295
1992	283	287
1993	225	225
1994	283	296
1995	169	176
1996	212	218
1997	68	106
1998	242	244
1999	242	263
2000	284	287
2001	301	319
2002	365	365
2003	326	327
2004	300	303
2005	229	266
Average	273.5	281.4



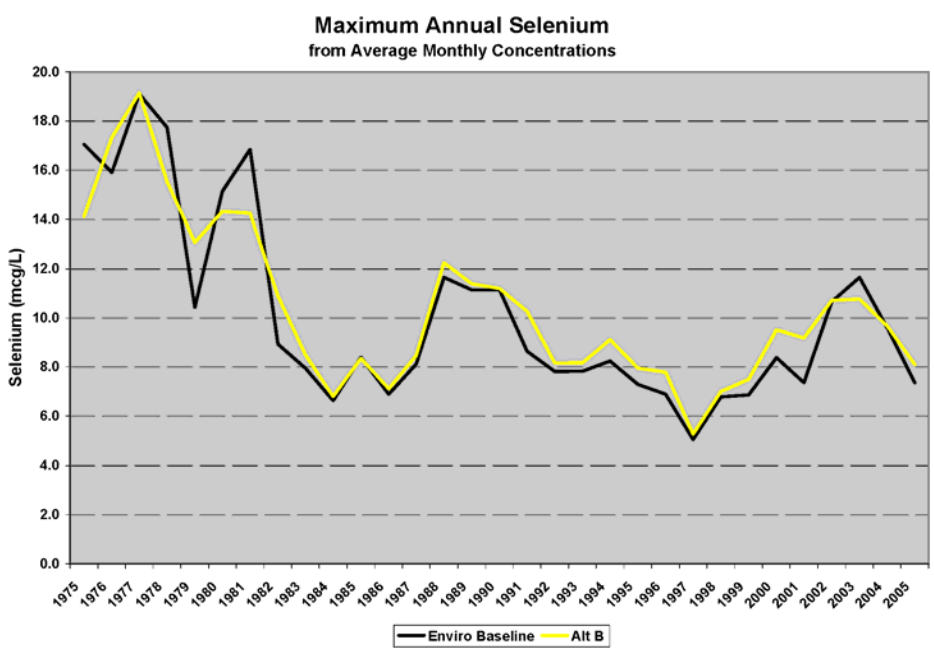


Figure 8. Selenium concentrations under baseline and proposed action, Whitewater gage.

6.5 Species Response to Proposed Action

As indicated in this assessment, there are a number of factors affecting the recovery of the endangered fish in the Gunnison River including reductions in habitat, competition with non-native fish, channelization, potential water quality concerns, and others. The proposed action does not resolve all of these factors but should improve conditions to increase recruitment and adult survival of the Colorado pikeminnow and razorback sucker in both the Gunnison and Colorado rivers and possibly the humpback in the Colorado River in conjunction with other Recovery Program actions. Response of the bonytail is unknown although the more natural hydrograph may have future benefits if populations are established.

In general, benefits of the proposed action include increased frequency and magnitude of relatively high spring flows to maintain channel conditions, spawning habitat, and channel complexity in critical habitat. The proposed flow regime should more closely resemble a natural flow regime when compared to baseline in that spring peaks would be greater in frequency, magnitude and duration, and that flows will vary among years in relation to snow pack and runoff. In addition to continuation of Recovery Program activities, the proposed action will provide benefits to the endangered fish and their habitat.

Species-specific effects of the proposed action are discussed below.

6.5.1 Colorado pikeminnow

6.5.1.1 Spawning

In all hydrologic categories, rising and falling hydrographs associated with the spring runoff from the North Fork and releases from the Aspinall Unit will provide environmental cues for Colorado pikeminnow spawning activity. Increased magnitude and duration of spring peak flows in the Gunnison River will maintain and improve spawning substrate by flushing fine sediment from the interstices of gravel and cobble substrates, which will improve survival of eggs and larvae. During moderately dry years, especially, increased frequency of peak flows between 2,600 and 8,070 cfs will improve spawning habitat even if widespread channel maintenance doesn't take place. Flows in the range of 4,400 to 5,300 cfs are also beneficial because they have the capacity to mobilize sand and finer sediments, which should function to keep spawning substrates relatively clean (Pitlick et al. 2007). At higher flows (average dry through wet years), cleansing of gravel and cobble bars will be much more widespread and would maximize Colorado pikeminnow reproductive success. Enhanced river flows in the Colorado River should elicit a similar response there.

With increased frequency of high flows comes a greater probability of delayed warming of the Gunnison River. Since Colorado pikeminnow spawn on the descending limb of the hydrograph (ca. 15-30% of the peak or 1-4 weeks after the peak; McAda and Kaeding 1991; Trammell and Chart 1999a; Anderson 1999), they tend to spawn later (ca. early to mid-July) during moderately wet and wet years and earlier during drier years (June; Figure 3.9 in McAda 2003). This adaptation is also related to the onset of favorable spawning temperatures (18-22 °C), which also occur later during wet years. Whereas spawning activity and hatching success should not be impeded directly by delayed warming, the growing season for offspring in wetter years is consequently shorter than during dry years. The effect may be partially offset due to greater connectivity with warm floodplain rearing habitats during wet years. Regardless, the trade-off facing Colorado pikeminnow between stream bed maintenance and temperature regime in the Gunnison River is an uncertainty that may need to be evaluated by the Recovery Program.

6.5.1.2 Larval and young-of-year habitat

As spring flows recede to base levels during the summer and fall, side channels and sandbar scour channels cease to flow and become backwaters. These are warm and productive environments which are important rearing habitat for larval and young-of-year Colorado pikeminnow. Under the proposed action, widespread maintenance of side channel and backwater habitats will occur at the half bankfull flow (8,070 cfs) in average dry to wet years, respectively. These flows would occur more frequently and with greater magnitude than those under baseline flows, helping to minimize vegetation encroachment, channel narrowing and vertical accretion of side-channel habitats. Cleansing of fine sediments from cobble bars and runs should also increase production of invertebrate prey items, on which juvenile stages of all endangered fish rely on for sustenance. Major changes in channel complexity will continue to depend on less frequent hydrologic events such as occurred in 1983, 1984 and 1993.

6.5.1.3 Adult habitat

The proposed action would help assure flows to operate the Redlands Fish Ladder from April through September and the Redlands Fish Screen. Due to shifts in water release volumes toward the spring peak period, the proposed action would result in an average of 32.2 days April through September below the migration minimum flow level compared to 22.3 days at baseline flows. Flows less than 100 cfs, which can significantly affect migration, would be increased by an average of 1.2 days under the proposed action (from 4.4 days to 3.2 days). Under both baseline and proposed action, most of the lower flows occur in very dry years, for example in 1977, 2002, and 2003 in the study period.

Higher and more frequent spring flows will provide more off-channel and floodplain habitat for feeding and resting of adult Colorado pikeminnow. These flows will also rework cobble bars, scour vegetation and help maintain overall channel complexity, the latter of which ensures a variety of habitats for Colorado pikeminnow feeding and resting throughout the course of a year. As mentioned above, also, flushing of fine sediments simultaneously prepares spawning habitat for Colorado pikeminnow and enhances primary and secondary productivity.

6.5.1.4 Non-native fish

Young-of-year Colorado pikeminnow share backwater rearing habitat with a host of non-native fish dominated by fathead minnow, sand shiner and red shiner. McAda and Ryel (1999) demonstrated that abundance of non-native cyprinid species during both summer (larvae) and autumn (juvenile and adults) was inversely correlated with magnitude of the previous spring peak flows, whereas relationship of young-of-year native fish to spring peak flows was either positive or statistically not significant. Thus, increased frequency and magnitude of spring peaks under the proposed action would disadvantage competitive and/or predatory non-native fish while not harming young-of-year native fish. Operation of the selective Redlands Fish Ladder would continue to prevent upstream migration of non-native fish into the Gunnison River.

6.5.1.5 Floodplain connectivity

In contrast with razorback sucker, Colorado pikeminnow reproduction is not as dependent on presence of floodplain wetlands for enhanced larval survival and growth. However, higher and more frequent spring flows will provide more off-channel and floodplain habitat for feeding and resting of adult Colorado pikeminnow prior to spawning, perhaps contributing to overall reproductive fitness.

6.5.1.6 Water quality

While flows in non-peak months will be reduced, base flows should remain adequate to continue to provide dilution flows and protect water quality (Tables 17-20). Other programs, such as salinity and selenium control programs, to protect/improve water quality will continue and will be supplemented by conservation measures associated with the proposed action and are expected to promote gradual improvements in water quality in the action area.

6.5.2 Razorback sucker

6.5.2.1 Spawning

Effects of the proposed action on razorback sucker spawning habitat would be very similar to those described for Colorado pikeminnow (Section 6.5.1.1). Since razorback sucker can spawn over a lower and wider range of temperatures (8-19 °C), delayed warming would probably not affect their larval growth and survival as much as it would Colorado pikeminnow.

6.5.2.2 Larval and young-of-year habitat

Effects of the proposed action on razorback sucker rearing habitat would be very similar to those described for Colorado pikeminnow (Section 6.5.1.2). Since razorback sucker rearing is thought to be more strongly associated off-channel floodplain wetlands, effects on those habitats are likely more important for razorbacks.

6.5.2.3 Adult Habitat

Effects of the proposed action on razorback sucker adult habitat would be very similar to those described for Colorado pikeminnow (Section 6.5.1.3). Like Colorado pikeminnow, adult razorback sucker utilize a variety of habitats throughout the course of the year and prefer complex river segments; thus, higher and more frequent spring peaks would work to maintain and perhaps improve channel complexity by mobilizing sediment, scouring vegetation and reducing accretion.

6.5.2.4 Non-native fish

Effects of the proposed action on non-native fish would be very similar to those described for Colorado pikeminnow (Section 6.5.1.4).

6.5.2.5 Floodplain connectivity

Razorback sucker spawning is timed to coincide with availability of inundated floodplains that provide warm, productive environments for larvae. Transport of larval fish into floodplains appears to be an important factor in determining recruitment of razorback sucker. In the Gunnison River, connection to important floodplain rearing habitats (Craig, Escalante, Confluence Park, and Johnson Boys' Slough) during the spring peak will be made under the proposed action more frequently and for longer durations than under baseline flows. The increase in duration of connection within a year is particularly important because a wider window of opportunity is open to drifting larvae for entrainment into productive rearing habitats. Additionally, the increased duration of flooding represents an opportunity for increased growth, since even short periods of inundation can provide the warm, food-rich habitat required for high survival of larvae (McAda 2003). This increased growth can be particularly important if size-dependent processes such as predation by small, gape-limited predators (e.g., red shiner) are important regulators of survival.

High flow connections (ca >14,000 cfs) to Escalante SWA are significant as they allow access to a 200 acre oxbow wetland, one of five tracts in the largest wetland complex in the Gunnison corridor. Both Colorado pikeminnow and razorback sucker are suspected to use these wetlands on a seasonal basis (Valdez and Nelson 2006). The connection to Craig is also significant as it has been recommended to receive stocking of hatchery-reared razorback sucker and could very likely entrain wild-spawned drifting larvae (Valdez and Nelson 2006).

6 .5.2.6 Water quality

Effects of the proposed action on water quality would be very similar to those described for Colorado pikeminnow (Section 6.5.1.6).

6.5.3 Humpback chub and bonytail

Benefits of the proposed action for humpback chub in the Colorado River would include most of what has been described for Colorado pikeminnow and razorback sucker, including:

- Spawning cues due to spring peak flows
- Maintenance of habitat complexity over a range of flows
- Maintenance of spawning gravel
- Creation and maintenance of backwaters
- Reduction of non-native fish due to higher flows

Attachment 9 summarizes expected changes in the Colorado River due to the proposed action.

Because of its extreme rarity, response of bonytail to the proposed action may be difficult to quantify. However, since all four endangered fish evolved together in the Colorado River ecosystem and the flow recommendations were based on common river restoration practices and habitat needs of the more common endangered species, bonytail should benefit from the proposed action as well.

6.6 Cumulative Effects

In the Service's regulations at 50 CFR 402.02, cumulative effects are defined as those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation. To the best of Reclamation's knowledge, there are no proposed, authorized or permitted water development projects or activities foreseen at the present time that have not been defined as part of the action. Therefore, despite Reclamation's finding that there may be adverse effects of listed species, state or private cumulative impacts are not projected.

6.7 Uncertainties and Take

Uncertainties discussed in the flow recommendations or related to the proposed action include:

- While relationships among initial motion, significant motion and streamflow are well defined, duration of flows necessary to accomplish habitat work is not completely known. Because flow duration recommendations were developed based on a wet period, the recommended durations require a large volume of water that may not always be available.

- Water availability may limit the ability of the Gunnison River to meet the Flow Recommendations under certain conditions.
- "…the duration of flows necessary to accomplish in-channel and out-of-channel habitat maintenance objectives is not known."[1]
- Because of timing and other differences in runoff patterns of the Colorado and Gunnison rivers, it is difficult to predict the effect of Gunnison River flow changes on the Colorado River.
- The trade-off facing Colorado pikeminnow between stream bed maintenance and temperature regime in the Gunnison River is an uncertainty that may need to be evaluated by the Recovery Program.
- The Recovery Program may need to evaluate the trade-off between high spring flows and base flows needed during the mid- to late summer to operate Redlands (and, to a lesser extent perhaps, maintain movement of sediment through the system).
- The effect of selenium and other water quality elements on the recovery of the endangered fish in the Gunnison and Colorado rivers and other basin rivers is not known and further monitoring by the Recovery Program may be needed.

For these reasons, the proposed action calls for using adaptive management (Section 2.2) to respond to new knowledge and using monitoring to evaluate the physical response of the habitat and biological response of the fish to the flow regimes.

Section 9 of the Endangered Species Act addresses "take". Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Take was considered in terms of continued diversions of water in critical habitat and in new and continued water depletions.

Incidental take associated with existing water diversions in Gunnison River critical habitat is difficult to assess but should not be significant. A previous biological opinion has addressed take for the Redlands Diversion, the only major diversion in critical habitat (Fish and Wildlife Service 2004). The other diversions in critical habitat are pumps or instream diversions for individual farms/orchards or small groups of users. These small diversions should pose little threat to adult and subadult fish. As fish recover and spawning increases in the Gunnison River, some loss of larval fish would be expected at these diversions; however because diversions generally divert well less than one percent of the river flow, losses should not be significant.

[1] Research under the Recovery Program is ongoing in the Gunnison River. Under one sediment-monitoring project the primary objective "…is to address key uncertainties in priority reaches of the Colorado, Gunnison, and Green Rivers relevant to the role of streamflows and sediment transport on the formation and maintenance of backwater habitats and spawning bars. A secondary objective is to collect the necessary sediment data to aide in the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir." (Fish and Wildlife Service 2006).

Continued and new depletions associated with the proposed action are considered an adverse effect and are intended to be offset by new operations. New depletions can affect habitat and reproduction/recruitment; however, estimating the number of individuals of these species that would be taken as a result of water depletions is difficult to quantify.

The number of larvae that may be incidentally taken as a result of any of these factors is unknown. However, because of the potential for loss of individual listed species in fish screens and diversions, Reclamation requests an incidental take statement.

Another form of take might be associated with foregone growth potential due to higher frequency of high flows and potentially lower water temperatures and also perhaps the trade-off of moving water into the peak season at the expense of flows later in the year.

7.0 CONCLUSIONS

Based on the information and analysis of effects in this PBA, the following determinations were made for each of the listed species in the action area.

Clay-loving wild buckwheat	*Eriogonum pelinophilum*	no effect
Uinta Basin hookless cactus	*Sclerocactus glaucus*	no effect
Jones' cycladenia	*Cycladenia humilis var. jonesii*	no effect
Yellow-billed cuckoo	*Coccyzus americanus*	no effect
Mexican spotted owl	*Strix occidentalis lucida*	no effect
Southwestern willow flycatche r	*Empidonax traillii extimus*	no effect
California condor	*Gymnogyps californianus*	no effect
Colorado pikeminnow	*Ptychocheilus lucius*	may affect, likely to adversely affect
Razorback sucker	*Xyrauchen texanus*	may affect, likely to adversely affect
Humpback chub	*Gila lacypha*	may affect, likely to adversely affect
Bonytai	*Gila elegans*	may affect, likely to adversely affect
Black-footed ferret	*Mustela nigripes*	no effect
Canada lynx	*Lynx Canadensis*	no effect
Gunnison's prairie dog	*Cynomys gunnisoni*	no effect
Uncompahgre fritillary butterfly	*Boloria acrocnema*	no effect

When compared to the environmental baseline, the proposed action will have overall beneficial effects on the razorback sucker and Colorado pikeminnow and their critical habitat and may benefit the bonytail and humpback downstream in the Colorado River. The new operations of the Unit along with future Recovery Program efforts and conservation measures will improve designated critical habitat conditions for the fish as compared to baseline conditions. However, there is a potential for take under both the baseline and under the proposal. This potential take from entrainment in canals and depletions could result in the harm or kill of individual endangered fish in the Gunnison or Colorado rivers. Therefore, due to the potential for take, the finding is that the proposed action may affect, is likely to adversely affect endangered fish species.

Other species considered in this PBA should not be affected by the proposed action.