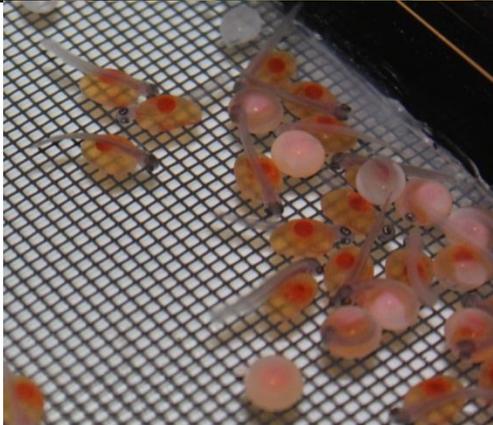
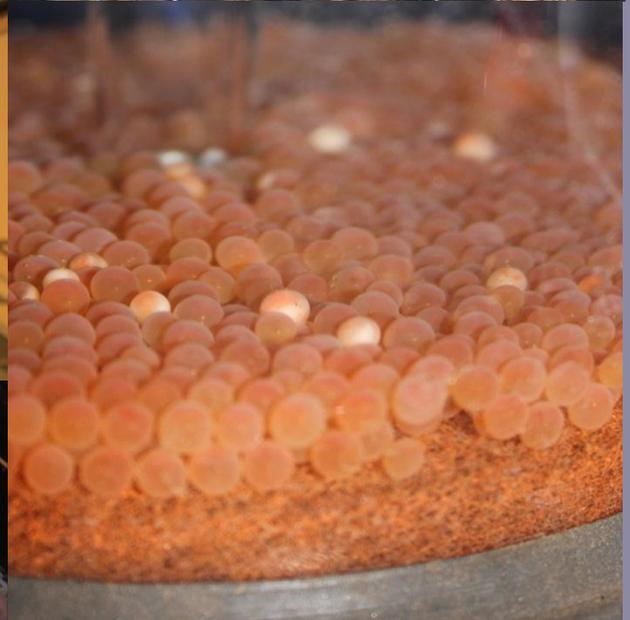


FY2015

Gila Trout Culture



Mora National Fish Hatchery

USFWS

FY2015

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Executive Summary

In FY2015, Mora National Fish Hatchery continued propagation and research activities for federally threatened Gila trout “*Oncorhynchus gilae gilae*”. These activities included genetic and fish health monitoring, broodstock management and research, and spawning and culture for recovery and recreational fishing streams.

Modifications to culture techniques and protocol in combination with environmental improvements greatly increased fish survival. All five recognized surviving Gila trout lineages are now on station. A total of nearly 15,300 Gila trout were released into recovery and recreational waters in the Gila drainage in both Arizona and New Mexico.

Domestic Spawning

The captive broodstock for the Main Diamond, South Diamond, and Whiskey Creek lineages of Gila Trout were spawned during the months of February and March. Each lineage was spawned on six different dates to fully capture the variability of “ripeness” for each lineage.

Mora NFH used paired matings in 2013 and all fish spawned were fin clipped and genetically analyzed for pair-wise relatedness by Dr. Wade Wilson at Southwestern Native Aquatic Resources and Recovery Center (ARRC). The samples were analyzed using the Relationship Coefficient (R_{xy}), where; 0-0.1 were unrelated, 0.1-.18 were cousins, 0.19-.38 were half siblings, and 0.39 were full siblings. Viable crosses were 0.18 and below.



Figure 1: Hatchery staff fertilizing Gila trout eggs.

In FY2015, hatchery staff switched to direct fertilization where the milt is expressed directly on to the eggs, instead of collection into micro-centrifuge tubes. Last year, staff observed condensation forming in the tubes which may have activated the milt early, decreasing fertilization rates.

Main Diamond

One hundred genetically appropriate 1x1 crosses were taken from the Main Diamond lineage resulting in 60,949 green eggs. Thirteen crosses of the Main Diamond lineage contained at least one wild parent, of which ten crosses produced viable offspring. 2015 represents the last attempt to spawn wild source Main Diamond fish transferred to the hatchery in 2011. Hatching was completed by the end of April and resulted in a final fry number of 30,404 or a hatch rate of 50.3%. Fecundity of each Main Diamond female was 609 eggs; 10% less than the long term average, but within yearly fluctuation rates. Individual cross information can be found in Appendix 1.

South Diamond

One hundred and fifteen genetically appropriate 1x1 crosses were taken from the South Diamond lineage resulting in 61,901 green eggs. Fifty three crosses of the South Diamond lineage contained at least one wild parent, of which thirty four produced viable offspring. Hatching was completed by the end of April and resulted in a final fry number of 30,345 or a

hatch rate of 49.0%. Fecundity of each South Diamond female was 538; 20% less than the long term average, but within yearly fluctuation rates. Individual cross information can be found in Appendix 2.

Whiskey Creek

Wild source fish were used this year to produce the 2015 broodstock. Forty-six genetically appropriate 1x1 crosses were taken from the Whiskey Creek lineage resulting in 41,436 green eggs. Fertilization and subsequent eye-up resulted in 14,481 fry or 35.95% hatch. Fecundity of each Whiskey Creek female was 901 eggs which was above average. Thirty-four families were retained for broodstock development. Individual cross information can be found in Appendix 3.

Iron Creek

Nine genetically appropriate 1x1 crosses were taken from the Iron Creek lineage resulting in 3,482 green eggs. Hatching was completed by the end of April and resulted in a final fry number of 4 or a hatch rate of 0.1%. Fecundity of each Iron Creek females was 387 eggs. Hatched alevins never developed. Individual cross information can be found in Appendix 4.

Spruce Creek

Five genetically appropriate 1x1 crosses were taken from the Spruce Creek lineage resulting in 683 green eggs. No eggs developed from these spawning crosses. Fecundity of each Spruce Creek female was 137 eggs. Individual cross information can be found in Appendix 5.

Future Broodstock 2015YC

In accordance with procedures outlined in the Broodstock Management plan, fish selected to be future broodstock were retained separately in 2015. Sixty-nine genetically suitable Main Diamond lineage families, seventy suitable South Diamond lineage families, and 32 suitable Whiskey Creek lineage families were pit tagged in August 2015. The families remained separated until they reached an appropriate size for PIT tagging. This allows the facility to identify each individual fish and maintain their family history for future spawning efforts.



Figure 2: Gila Trout clipped for genetic analysis

Stocking and Transfers

A total of 11,391 Gila trout were released for recovery in Arizona and New Mexico; 25 fish were transferred for outreach purposes; and 3,878 determined to be excess to recovery were released in recreational waters in both Arizona and New Mexico. A complete list of stocking sites can be found in Appendix 6.



Figure 3. Gila trout being released at Black Canyon

Wild Broodstock – Naturalistic Rearing

The Mora NFH periodically receives wild fish for incorporation into the captive broodstock in accordance with the Gila Trout Broodstock Management Plan. This process prevents genetic drift that may otherwise occur in a hatchery setting. The wild fish are reared in naturalistic rearing and poly-cultural systems that simulate natural conditions. The tanks are painted an earthen color and are lined with rock substrate, artificial cover including plants and resin root structures, and fish that co-occur in the wild, such as desert and Sonoran suckers. During the acclimation



Figure 4. Gila Trout in a naturalistic system

period, the wild fish are fed a live diet that is supplemented to pelletized feed. As the fish transition to pelleted food, the live diet is gradually reduced as the pelleted diet provides a balanced nutrition source and micro and macronutrients needed for egg production.

Tank substrate is generally removed from tanks prior to the spawning season so that males do not induce female spawning in gravel. In early FY2015, hatchery staff modified the Whiskey Creek isolation system by removing substrate (to prevent early spawning), installing a central drain system, and adding inlet jets. This design was suggested by Jack Christinasen, Aquaculture Engineer, to improve water quality. Water quality in Whiskey Creek holding units had deteriorated as the biomass of Whiskey Creek fish had increased substantially over their 3 years of holding. The center drain design with dual stand-pipes pulls waste off the bottom of the tank continuously and sends it to a microscreen for collection. Water inlet jets thoroughly mix the rearing water to ensure optimum dissolved oxygen conditions in the rearing tank.

The hatchery staff also modified the raceways in Systems 1 and 2 with the addition of baffles. Baffles improved waste flow to the quiescent zone, where it was vacuumed and removed prior to entering the recirculating bio-system. The efficient removal of waste improved water quality and reduced stress from physically brooming waste to the quiescent zone. These systems hold the Main and South Diamond domestic broodstock.

During 2015 spawning operations, the Whiskey Creek wild and Main and South Diamond domestic broodstocks, had substantially better cross success than other wild lineages. Cross success (measured by successful female spawns) is very important to ensure maximum genetic diversity in the resulting F1 generations. Staff attributed cross success to improved water quality and subsequent rearing conditions for broodstock during the critical egg development period.

Based on these data, the staff plans to modify the remaining rearing systems to incorporate the new modifications in FY2016.

Lineage and Source	Total Crosses (females)	Failed Crosses (females)	Success %	Modified
Main Diamond Domestic	90	12	87	Yes
South Diamond Domestic	99	18	82	Yes
Whiskey Creek Wild	46	9	80	Yes
South Diamond Wild	17	13	23	No
Main Diamond Wild	8	10	20	No
Iron Creek Wild	9	8	11	No
Spruce Creek Wild	5	5	0	No

Table 1. Female spawning success by rearing unit type

Main Diamond

The wild Main Diamond lineage Gila trout were captured and transferred to the hatchery on August 18, 2011. The fish were placed in a newly designed and constructed system located in

the repurposed Visitor's Center building. Thirteen half wild/ half domestic crosses were taken in 2015 and ten were successfully added to the domestic lineage. The remaining adult fish were returned to the wild in June 2015.

A new lot of wild source Main Diamond lineage Gila trout is slated to be transferred to the hatchery in the Fall of 2015.

South Diamond

The wild South Diamond lineage Gila trout were captured and transferred to the hatchery on May 22, 2013. The fish were sorted into three size classes and were placed in the east side of "Shady Acres". Fifty three half wild/ half domestic crosses were taken in 2015 and thirty four were successfully added to the domestic lineage. The remaining fish are slated to be incorporated into broodstock development in 2016. Thirty-one spawned fish were returned to the wild in June 2015.

Whiskey Creek

The Whiskey Creek lineage consists of two source populations, one removed from Whiskey Creek and the other removed from Langstroth Creek.

The Whiskey Creek replicate lineage was transferred from the New Mexico Fish and Wildlife Conservation Office in the spring of 2013. These fish were evacuated from Whiskey Creek in 2012 following the aftermath of Whitewater-Baldy Complex fire.

They were held at the NMFWCO until construction was finished on a new culture system at Mora. Prior to transfer, the fish were PIT tagged and had a genetic fin clip taken.



Figure 5 . Ovarian fluid collection in unfertilized Whiskey Creek eggs. USFWS

The Langstroth Creek replicate was transferred on June 16, 2012 and was placed into a temporary system in the Visitor's Center until a dedicated and permanent system was created. The new system was operational by the end of December 2012. The new system consists of four 600-gallon tanks that are not interconnected. During culture, staff observed numerous

instances of aggressive behavior. The design philosophy for this system was focused on isolation of the different sized fish from each other as this was seen a common trigger in the aggressive behavior.

Broodstock Development continued in 2015 with thirty-two families retained for future broodstock, with special emphasis been given to families that were tagged as high priority by Dr. Wade Wilson at Southwestern Native ARRC.

Spruce Creek

Eighty-two wild Spruce Creek lineage Gila trout were transferred from Ash Creek, Arizona, on November 5, 2014 and were placed into the isolation system in the quarantine room. This lineage appears more docile, with a complete lack of observed aggressive behavior. Broodstock development began in 2015, with five genetically appropriate crosses being taken, but with no successful crosses produced. Overall, the quality of the take was poor, with inferior egg quality and meager quantities of milt. The fish also spawned extremely early (December), and hatchery staff speculates that the late transfer and warmer water temperatures (relative to Ash Creek) caused the fish to spawn early. Broodstock development will continue in FY2016.

Iron Creek

Fifty-six Iron Creek lineage Gila trout were captured and transferred on May 15, 2013. These fish were thought extirpated in 2012 following the aftermath of Whitewater-Baldy Complex fire, but survivors were located in the spring of 2013. Originally thought to be hybrids, later genetic work indicated that they were pure strain. The fish were sorted into three size classes and were placed in the west side of "Shady Acres". Broodstock development began in 2015, with nine genetically appropriate crosses being taken, but with no successful crosses produced. Overall the quality of the take was mediocre, with inferior egg quality and meager quantities of milt. Broodstock development will continue in FY2016.

Fish Health Inspection

The annual fish health inspection was performed on August 10-11, 2015 by a crew of two from the Southwestern Fish Health Unit. Hatchery staff provided support during the process and also collected length-weight data before dissection. Diagnostics will be completed by September 15, 2015.

Hatchery Data

Hatchery data, including conversions, condition factors, and growth data are included in Appendix 7. Most data are typical of the previous five years.

Directorate Resource Assistants Fellows Program (DFP)

The Mora National Fish Hatchery was selected to host one of 2015's DFP interns. Morgan Brizendine was selected for the position and she started on June 1 for the eleven week program. Her research project was titled "Physical performance and condition of Gila trout exercised and reared with natural media." The project was based on recent work in the Pacific Northwest that has shown increased swimming speeds

of captive salmonids has improved fitness and resulted in 200% gains in smolt to adult survival rates (Murauskas 2012). Salmonids reared in "exercised" environments more closely match wild fish and have higher survival rates post-stocking. Morgan produced an interim report on her research project, but due to the limited timeframe of the actual project, differences between the trials had yet to appear. Hatchery staff will continue the project until release to add time so that differences can appear in the treatments. Morgan has graciously agreed to expand her interim report with the additional data. The interim report can be found in attachment 1.

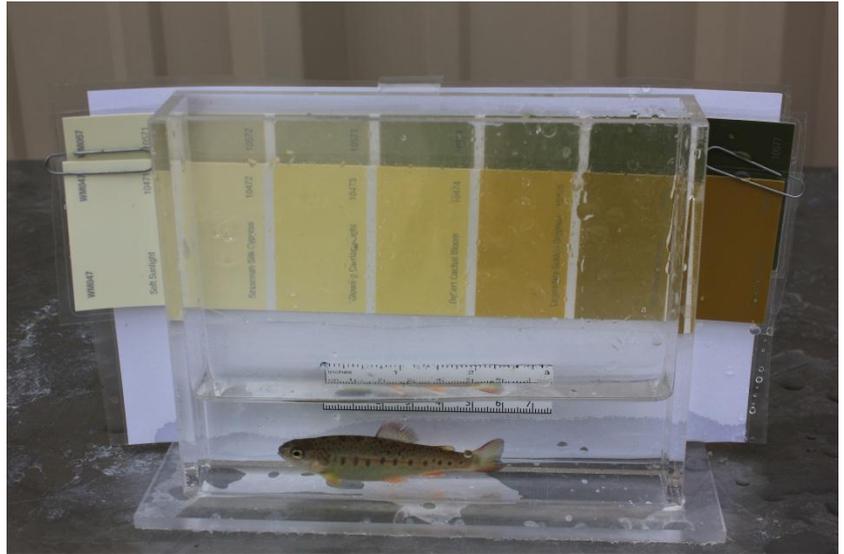


Figure 6. Evaluating coloration of Gila trout.. USFWS

Cultural Improvements

Aquariums Added

Mora NFH only had the capacity to keep 112 families separate for broodstock development. This limitation impacted recovery efforts. Additional aquarium stands were refurbished and installed between existing units. Plumbing was rerouted and connected to existing lines. These new units increased family capacity to 144. This project is particularly important in light of all five lineages now on station.



Figure 7. New aquarium banks in place. USFWS

Space for further expansion of the aquarium banks is very limited, and hatchery staff is considering the use of Z-Habitats from Aquatic Eco-Systems. These units contain 60 ten liter tanks in a compact footprint that would maximize use of the remaining floor space. In the next 2-3 years, the hatchery anticipates the need for 400 family units for broodstock development of all five lineages.

Infrastructure Audit

In November 2014, Jack Christiansen, Aquaculture Engineer from the Lower Snake River Compensation Program; Jae Ahn, Facility Operation Specialist from the Fish and Aquatic Conservation Regional Office; Mark Orton R2 Energy (Mechanical/Electrical) Engineer, Engineering Division of the Regional Office; and James Salasovich from the National Renewable Energy Laboratory, conducted an infrastructure and operations audit of the Mora National Fish Hatchery.

The audit provided Mora National Fish Hatchery with ample conceptual-level information of the current infrastructure challenges. As a result of the audit and follow-up collaboration with all who participated, a strategic approach to meet these challenges through in-house and external efforts will allow the Hatchery to reach untapped potential. These efforts will result in significant improvements in water quality, program capacity, efficiency, and adaptability at the facility. The complete document can be found in attachment 2.

Reuse System 3 Maintenance

System 3 was shut down for maintenance and repairs in December 2014. The last time that this system was down for maintenance was in 2010. Drum seals have been long out of production, and staff worked with the manufacturer to find functional workarounds. Work completed included removing the 80 micron filter panels, applying a foam gasket along the perimeter of each panel and reinstallation; removal and



Figure 8. Applying adhesive for new seals. USFWS

cleaning of sprayer bar nozzles and sockets; sealing of leaking circular tanks; removal, cleaning, and re-installation of the drum seal; replaced anodes; and pressure-washing of the drum filter support structure to remove four years' worth of accumulated grime and calcium deposits. The system was operational by March 2015.

Reuse System 3 Ultra-Violet Disinfection Unit

The hatchery staff had installed UV disinfection units on all of the recirculation systems; however, these units were too small to treat the entire volume of water for each system and were installed "side-stream" thereby severely reducing their effectiveness. Hatchery staff worked with a manufacturer to custom design a UV unit that was capable of fitting into the limited space available in each system and was capable of treating up to 1000 gpm at 210,000 milli-joules, a dosage that kills all but the hardest fungi. As with all prototype or custom units there were a few hiccups, but once operating, there was an immediate improvement in fish health. Mora NFH is on track to receive funding for an additional two units to be installed on the other large systems, and with knowledge gained with this installation, the remaining units should go much more smoothly.

Raceway Baffles

Hatchery staff installed new screen slots and baffle plates into all raceways in FY2015. The baffles force the water down and under thereby effectively moving solids in each tank. This modification improved conditions in the rearing unit and reduced weekly manpower for cleaning. The new screen slots also allow the creation of a large quiescence zone that allow staff to remove solids before they enter the treatment process, reducing nutrient loading in the hatchery's effluent discharge.



Figure 9. Raceway baffles installed. USFWS

Incubation System

The hatchery completed a new de-gassing system to utilize well-water for the incubation of Gila trout eggs. Previously, re-circulated water was used for incubation, and was identified as a future improvement during the Infrastructure and Operations Audit in 2014. The used incubation water will be re-circulated back to System 3 for use on start-up fish. The new system reduces water demand by double-stacking the incubation units and utilizing the head-pressure from the reservoir for supply. This change provides the best quality water to the most critical stages of incubating eggs. The crew also added an O₂ contactor to increase oxygen saturation from 85% to 100%.

The new system worked very well, reducing formalin usage in the vertical stack incubators, improving water quality for the developing fry, and improved overall hatching success. Improvements planned for FY 2016 include adding five additional stacks of incubators for broodstock development and adding an additional head tank and chillers to further condition the water.

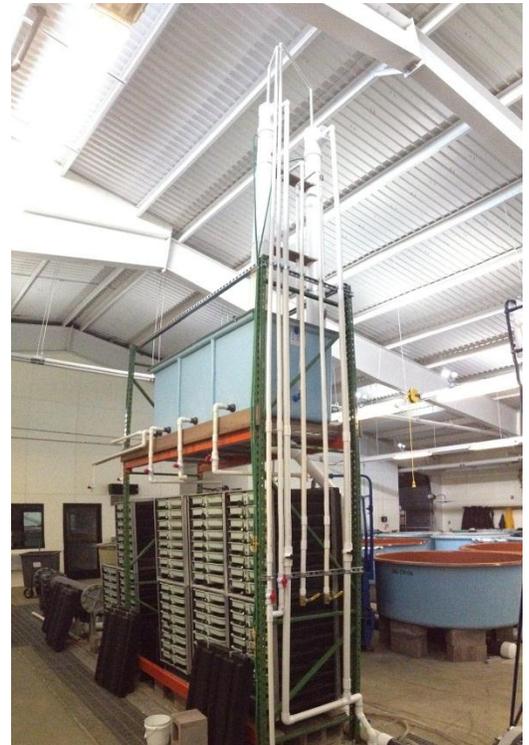


Figure 10. Incubation System. USFWS

Cyro-Preservation of Rare Lineages

William Wayman and Jackyn Selko from the Warm Springs Fish Technology Center performed cryo-preservation experiments at Mora NFH during March. Seventy-two replicates of 250 eggs each were completed with excess Main and South Diamond broodstock. Hatchery staff injected non-viable males with LHRHa to induce milt production, in the week prior to the arrival of the Warm Springs FTC personnel. The following lineages were cryopreserved and shipped back to Warm Springs for storage: Whiskey Creek 42 males (85% of available)



Figure 11. Cyro-Preservation efforts. USFWS

Iron Creek 11 males (62% of available) Spruce Creek 4 males (20% of available). Of the three milt extenders tested, the Glucose-Methanol extender proved superior to Hank's balanced salt solution and Cloud extender. The preserved fertilization rate with this extender was equal to fresh sperm in several cases. Bill Wayman was "very happy" with the results.

Treatment	Dewar 1	Dewar 2	Platform 1	Platform 2
Fresh	19.4	25.1	55.5	44.7
Clear	3.3	6.4	17.1	2.7
Red	1.6	5.3	5.6	1.2
Yellow	11.8	28.8	58.4	34.1

Table 2: Percentage Hatch by Treatment

Treatments are:

Fresh is regular sperm - not frozen - used as a control for egg quality

Yellow is Glucose-Methanol extender and is what we used for the mass freezing of sperm from the broodstock lines.

Red is Hanks' balanced salt solution and is what Adam Fuller used a few years ago.

Clear is Cloud extender and is what we used for salmonids.

Dewar and Platform correspond to different freezing rates, and each was done twice.

Hatchery SOPs Developed

Hatchery staff began developing Standard Operation Procedures (SOPs) in FY2015. The development of this reference source will give new staff and volunteers a starting point for their orientation to the hatchery. Staff envisions that the SOPs will eventually cover all aspects of hatchery operation, and when completed, each new employee or volunteer will receive a binder with this information. The preliminary SOPs can be found in attachment 3.

Projected Production and Stocking Needs

Stocking requests for the fall of 2015 are listed below. The late spring 2016 stocking represents retired broodstock and would most likely be used for fishing derbies in New Mexico and Arizona. Stocking numbers for the fall of 2016 are yet to be determined. The 2016 spawning plan can be found in appendix 8.

Fall 2015	Late Spring 2016
Little Creek, NM 2,500 2015MD	~ 350 2013MD
Black Canyon, NM 3,500 2015MD	~300 2013SD
Upper Langstroth, NM 4,000 2015MD	~ 70 wild 2011WC
Dude Creek, AZ 500 2015MD	~ 80 wild 2012SD
Willow Creek, NM 3,050 2015SD	
Willow Creek, NM (below) 2,500 2015SD	
South Diamond Creek, NM 1,500 2015SD	
Mineral Creek, NM 2,500 2015SD	
Dude Creek, AZ 500 2015SD	
Upper White Creek, NM 3,000 2015WC	
Sacaton Creek, NM 1,500 2015WC	
Ash Creek, NM 500 2015WC	
Frye Mesa Reservoir, AZ* 6,000 2015 MD/SD	
West Fork Oak Creek, AZ* 1,000 2015 MD/SD	

*Depending on approved management plans

References

Murauskas, J. (2012, December) Increased Performance of Spring Chinook Salmon Reared in Partial Re-Use Circular Vessels Compared to Flow Through Raceways. Paper

Presented at the 63rd Annual Northwest Fish Culture Conference Proceedings, Portland, OR

Appendix 1. 2013 Main Diamond Spawning Crosses

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/10/2015		66013	27962	D2:1-2	50	607	974	67.5
3/10/2015		17003	65986	D2:1-3	50	485	862	62.1
3/10/2015		17009	32042	D2:1-4	50	351	813	49.3
3/10/2015		66090	27928	D1:8-1	50	275	411	79.1
3/10/2015		27946	66001	D1:8-2	50	1569	1856	87.2
3/10/2015		27863	17088	D1:8-3	50	537	610	96.2
3/10/2015		32183	32186	D1:8-4	50	701	1023	73.4
3/10/2015		17036	66015	D1:8-5	50	327	847	44.5
3/10/2015		65990	32084	D1:8-6	50	134	218	84.4
3/10/2015		27977	66096	D1:7-1	50	491	1294	41.8
3/11/2015		65948	17037	D1:7-2	50	507	615	90.6
3/11/2015		16887	66145	D1:7-3	0	118	323	36.5
3/11/2015		65995	16949	D1:7-4	50	97	202	72.8
3/11/2015		27870	17090	D1:6-1	0	81	120	67.5
3/11/2015		27969	27862	D1:6-2	50	598	736	88.0
3/11/2015		16967	27934	D1:6-3	0	31	210	14.8
3/11/2015		32094	16942	D1:6-4	50	285	373	89.8
3/11/2015		32138	65988	D1:6-5	50	511	590	95.1
3/11/2015		32010	16938	D1:6-6	0	0	200	0.0
3/11/2015		65987	16964	D1:5-1	50	124	534	32.6
3/11/2015		17048	16918	D1:5-2	50	190	273	87.9
3/11/2015		27958	27952	D1:5-3	50	683	774	94.7
3/11/2015		32201	65950	D1:5-4	50	615	731	91.0
3/11/2015		16958	27846	D1:5-5	50	857	1122	80.8
3/11/2015		17054	66072	D1:5-6	50	254	318	95.6
3/11/2015		16894	66022	D1:4-1	0	156	188	83.0
3/11/2015		17063	66009	D1:4-2	0	116	895	13.0
3/11/2015		32015	65956	D1:4-3	50	215	780	34.0
3/11/2015		66044	16913	D1:4-4	0	0	250	0.0
3/11/2015		66007	27979	D1:3-1	50	222	301	90.4
3/17/2015		65983	32045	C2:5-5	50	399	569	78.9
3/17/2015		65973	32055	C2:5-6	50	517	802	70.7
3/17/2015		16898	17056	C2:4-1	50	440	603	81.3
3/17/2015		66079	27936	C2:4-2	50	361	508	80.9
3/17/2015		32161	66024	C2:4-3	50	377	920	46.4

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/17/2015		65967	27972	C2:4-4	50	82	793	16.6
3/17/2015		27970	66112	C2:4-5	0	86	116	74.1
3/17/2015		27911	17087	C2:4-6	0	201	875	23.0
3/17/2015		66025	32065	C2:3-1	50	237	335	85.7
3/17/2015		17026	65951	C2:3-2	50	133	368	49.7
3/17/2015		27898	66109	C2:3-3	0	0	2000	0.0
3/18/2015		27941	16931	C2:2-1	50	471	1101	47.3
3/18/2015		27944	66035	C2:2-2	50	237	305	94.1
3/18/2015		17066	27854	C2:2-3	0	151	242	62.4
3/18/2015		17034	16916	C2:2-4	50	27	316	24.4
3/18/2015		66122	32030	C2:2-5	50	519	758	75.1
3/18/2015		17078	32046	C2:2-6	50	337	439	88.2
3/18/2015		16841	16957	C2:1-1	50	332	541	70.6
3/18/2015		16947	65982	C2:1-2	50	297	415	83.6
3/18/2015		66003	65974	C2:1-3	0	0	1000	0.0
3/18/2015		27848	65992	C2:1-4	0	0	1000	0.0
3/18/2015		66027	65964	C2:1-5	50	373	753	56.2
3/18/2015		66073	16877	C2:1-6	50	751	882	90.8
3/18/2015		32061	66054	C1:8-1	50	323	511	73.0
3/18/2015		66061	65975	C1:8-2	0	10	199	5.0
3/18/2015		66115	32035	C1:8-3	0	0	907	0.0
3/18/2015		32018	65953	C1:8-4	50	271	542	59.2
3/18/2015		17048	16844	C1:8-5	0	339	472	71.8
3/18/2015		65970	66144	C1:8-6	50	270	447	71.6
3/18/2015		32017	27935	C1:7-1	50	22	229	31.4
3/18/2015	x	65989	29359	B2:8-1	31	0	846	3.7
3/18/2015	x	87516	32852	B2:8-2	0	0	907	0.0
3/18/2015	x	60887	43889	B2:8-3	50	218	1774	15.1
3/18/2015	x	33495	13498	B2:8-4	50	154	1156	17.6
3/18/2015	x	56705	27903	B2:7-1	0	0	2000	0.0
3/18/2015	x	58808	65962	B2:7-2	50	181	860	26.9
3/23/2015		17082	32175	B1:8-1	0	0	153	0.0
3/23/2015		32009	32072	B1:8-2	50	166	234	92.3
3/23/2015		16991	32187	B1:8-3	100	237	462	72.9
3/23/2015		16890	27961	B1:8-4	60	0	378	15.9
3/23/2015		32173	65963	B1:7-1	48	0	255	18.8
3/23/2015		16955	66048	B1:7-2	0	0	141	0.0
3/23/2015		65965	32163	B1:7-3	100	642	775	95.7
3/23/2015		65971	66012	B1:7-4	94	0	111	84.7

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/23/2015		66029	17007	B1:6-1	100	247	494	70.2
3/23/2015		65960	32137	B1:6-2	0	0	200	0.0
3/23/2015		32147	16986	B1:6-3	54	0	168	32.1
3/23/2015		17035	16876	B1:6-4	100	731	903	92.0
3/23/2015		27897	17084	B1:5-4	0	0	225	0.0
3/23/2015		66039	27984	B1:5-3	100	292	474	82.7
3/23/2015		16960	65981	B1:5-2	100	484	906	64.5
3/23/2015		66019	17059	B1:5-1	100	61	180	89.4
3/23/2015		17077	27851	B1:4-1	0	0	121	0.0
3/23/2015	X	84780	27923	B2:1-4	0	3	410	0.7
3/30/2015		32083	65991	A2:4-1	100	336	513	85.0
3/30/2015		32147	27933	A2:4-2	60	0	214	28.0
3/30/2015		65998	16872	A2:4-3	130	410	776	69.6
3/30/2015		17052	27889	A2:4-4	100	249	402	86.8
3/30/2015	X	42085	32171	A2:5-1	120	0	600	20.0
3/30/2015	X	56453	27960	A2:5-2	100	383	1037	46.6
3/30/2015	X	27837	27905	A2:5-3	100	214	1426	22.0
3/30/2015	X	60455	66042	A2:5-4	100	104	640	31.9
4/6/2015		16919	65978	A1:8-1	100	459	572	97.7
4/6/2015		65968	27890	A1:8-2	100	385	755	64.2
4/6/2015		16950	66093	A1:1-3	100	325	481	88.4
4/6/2015		32124	32039	A1:1-4	100	204	351	86.6
4/6/2015		32086	66026	A1:7-1	100	232	488	68.0
4/6/2015		66030	66099	A1:7-2	100	176	401	68.8
4/6/2015	x	65752	16129	A1:7-3	0	14	469	3.0
4/6/2015	x	27892	59316	A1:7-4	0	0	300	0.0

Totals 4,797 25,607 60,949 49.9

Appendix 2. 2015 South Diamond Spawning Crosses

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/2/2015		66373	66058	E2:7-1	50	981	1112	95.1
3/2/2015		66337	66419	E2:7-2	50	651	868	81.8
3/2/2015		66051	66326	E2:7-3	0	0	771	0.0
3/2/2015		66369	66202	E2:7-4	0	0	246	0.0
3/2/2015		66292	66393	E2:7-5	50	262	484	65.9
3/2/2015		53696	66444	E2:7-6	50	466	670	78.1
3/2/2015		66233	66347	E2:6-1	50	588	899	71.1
3/2/2015		66215	66335	E2:4-1	0	1	541	0.2
3/2/2015		66401	66277	E2:6-2	0	10	439	2.5
3/2/2015		66406	66416	E2:4-2	50	677	780	93.6
3/2/2015		66413	66283	E2:6-3	50	422	523	92.9
3/2/2015		66193	66315	E2:4-3	0	0	687	0.0
3/2/2015		53679	66443	E2:4-4	50	206	738	35.1
3/2/2015		53724	66443	E2:3-1	50	273	401	81.3
3/2/2015		66149	53710	E2:6-4	50	118	311	55.0
3/2/2015		66397	66182	E2:5-1	0	9	688	4.1
3/2/2015		66417	66309	E2:5-2	0	0	744	0.0
3/2/2015		53669	66440	E2:5-3	50	330	533	81.8
3/2/2015		65949	66302	E2:3-2	50	421	1338	35.2
3/2/2015		66186	66166	E2:5-4	50	525	641	90.0
3/2/2015		66218	66195	E2:3-3	50	616	764	88.2
3/2/2015		53701	66288	E2:3-4	50	0	361	13.9
3/2/2015		66365	66238	E2:3-5	50	919	1325	75.1
3/2/2015		66312	66063	E2:3-6	50	356	856	49.4
3/2/2015		53720	66396	E2:2-1	50	356	503	84.1
3/2/2015		66415	66382	E2:2-2	0	0	2208	0.0
3/2/2015		66364	66429	E2:2-3	50	633	931	80.9
3/2/2015		53686	66280	E2:2-4	0	39	1206	3.2
3/2/2015		66426	66206	E2:1-1	0	2	553	0.4
3/2/2015		66392	66319	E2:1-2	50	218	1270	21.7
3/2/2015		65949	66197	E2:1-3	50	419	814	57.7
3/2/2015		66251	66285	E2:1-4	0	0	547	0.0
3/2/2015		53632	66284	E2:1-5	0	3	606	0.5
3/9/2015	X	53666	82416	E1:3-1	50	420	514	91.4
3/9/2015	X	82457	66191	E1:3-2	0	0	139	0.0
3/9/2015	X	66403	82501	E1:3-3	50	357	422	96.4
3/9/2015	X	66412	82572	E1:3-4	50	100	188	79.8

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/9/2015	X	66308	82576	E1:2-1	50	638	735	93.6
3/9/2015	X	53681	82509	E1:2-2	50	32	131	62.6
3/9/2015	X	66414	82428	E1:2-3	50	138	193	97.4
3/9/2015	X	66398	82510	E1:2-4	50	167	251	86.5
3/9/2015	X	66295	82466	E1:1-1	50	347	442	89.8
3/9/2015	X	66369	82588	E1:1-2	50	89	153	90.8
3/9/2015	X	66080	82603	E1:1-3	50	488	697	77.2
3/9/2015	X	66268	82587	E1:1-4	50	383	454	95.4
3/9/2015	X	82531	66188	E1:1-5	0	0	285	0.0
3/9/2015	X	82578	66201	E1:1-6	0	5	514	1.0
3/9/2015	X	82545	66069	D2:8-1	0	0	501	0.0
3/9/2015	X	82470	53668	D2:8-2	50	400	587	76.7
3/9/2015	X	82489	66052	D2:8-3	0	0	472	0.0
3/10/2015	X	66252	82570	D2:7-1	50	349	451	88.5
3/10/2015	X	66381	82453	D2:7-2	50	414	628	73.9
3/10/2015	X	66075	82602	D2:7-3	50	455	543	93.0
3/10/2015	X	66085	82427	D2:6-1	0	51	128	39.8
3/10/2015	X	66385	82461	D2:6-2	50	583	735	86.1
3/10/2015	X	66409	82543	D2:6-3	50	749	866	92.3
3/10/2015	X	53723	82582	D2:7-4	50	334	415	92.5
3/10/2015	X	66150	82534	D2:6-4	0	2	456	0.4
3/10/2015	X	66441	82471	D2:5-1	50	394	1034	42.9
3/10/2015	X	53652	82512	D2:5-2	0	0	243	0.0
3/10/2015	X	66373	82548	D2:5-3	50	158	239	87.0
3/10/2015	X	66159	82529	D2:5-4	50	151	214	93.9
3/10/2015	X	66356	82440	D2:4-1	50	83	566	23.5
3/10/2015	X	53669	82563	D2:4-2	50	114	193	85.0
3/10/2015	X	53687	82451	D2:4-3	0	0	99	0.0
3/10/2015	X	66353	82542	D2:4-4	0	2	402	0.5
3/10/2015	X	66183	82608	D2:3-1	50	9	214	27.6
3/10/2015	X	82485	66350	D2:3-2	0	0	160	0.0
3/10/2015	X	82546	66282	D2:3-3	0	0	200	0.0
3/10/2015	X	82500	66343	D2:3-4	0	0	250	0.0
3/10/2015	X	82495	66058	D2:2-1	0	0	520	0.0
3/10/2015	X	82503	66163	D2:2-2	0	0	115	0.0
3/10/2015		53720	66210	D2:2-3	50	717	1001	76.6
3/10/2015		53699	66104	D-2:2-4	50	508	598	93.3
3/10/2015		66436	66442	D2:1-1	0	14	338	4.1
3/17/2015	X	66180	82455	D1:1-1	50	291	396	86.1

Spawn Date	Wild?	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/17/2015	X	66168	82552	D1:1-2	50	365	838	49.5
3/17/2015	X	66216	82516	D1:1-3	50	89	570	24.4
3/17/2015	X	82479	66358	D1:1-4	0	0	351	0.0
3/17/2015	X	82539	66175	C2:8-1	50	157	212	97.6
3/17/2015	X	82612	66384	C2:8-2	0	0	527	0.0
3/17/2015		66253	66185	C2:8-3	50	275	328	99.1
3/17/2015		53687	66399	C2:8-4	0	0	667	0.0
3/17/2015		66203	66368	C2:7-1	50	148	376	52.7
3/17/2015		66234	53702	C2:7-2	50	356	483	84.1
3/17/2015		66433	66411	C2:7-3	50	667	826	86.8
3/17/2015		66200	53628	C2:7-4	50	337	799	48.4
3/17/2015		66349	53667	C2:7-5	50	237	314	91.4
3/17/2015		66331	66242	C2:7-6	50	843	957	93.3
3/17/2015		53680	66263	C2:6-1	50	240	334	86.8
3/17/2015		66439	66152	C2:6-2	0	216	702	30.8
3/17/2015		66281	66167	C2:6-3	50	372	712	59.3
3/17/2015		66235	66248	C2:6-4	0	0	196	0.0
3/17/2015		66430	66207	C2:6-5	0	369	381	96.9
3/17/2015		66367	66174	C2:6-6	50	573	694	89.8
3/17/2015		66303	66173	C2:5-1	50	297	418	83.0
3/17/2015		66241	66449	C2:5-2	0	0	386	0.0
3/17/2015		66332	66231	C2:5-3	0	167	300	55.7
3/17/2015		66407	66374	C2:5-4	50	351	427	93.9
3/23/2015	X	66448	82429	B2:3-1	0	0	482	0.0
3/23/2015	X	66121	82476	B2:3-2	0	0	702	0.0
3/23/2015	X	66230	82609	B2:3-3	0	0	315	0.0
3/23/2015	X	66421	82468	B2:3-4	0	0	439	0.0
3/23/2015	X	66366	82562	B2:2-1	0	0	193	0.0
3/23/2015	X	53644	82540	B2:2-2	100	174	369	74.3
3/23/2015	X	82518	66237	B2:2-3	0	0	432	0.0
3/23/2015	X	82517	66184	B2:2-4	100	142	307	78.8
3/23/2015		66267	66083	B2:1-1	100	247	353	98.3
3/23/2015		66420	66428	B2:1-2	100	111	475	44.4
3/23/2015		53643	66410	B2:1-3	100	1099	1423	84.3
3/30/2015		66445	53631	A2:8-1	0	0	239	0.0
3/30/2015		66318	66142	A2:8-2	52	0	296	17.6
3/30/2015		66107	66198	A2:8-3	100	0	394	25.4
3/30/2015		66279	53717	A2:8-4	207	0	457	45.3
3/30/2015		66190	66386	A2:7-1	61	0	187	32.6

Totals 4,070 26,275 61,901 49.0

Appendix 3. 2015 Whiskey Creek Spawning Crosses

Spawn Date	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/11/2015	71332	83767	D1:3-2	0	5	305	1.6
3/11/2015	71577	71371	D1:3-3	0	2	312	0.6
3/11/2015	74360	71335	D1:2-1	50	331	834	45.7
3/11/2015	71352	84328	D1:2-2	0	0	250	0.0
3/19/2015	71304	83402	B2:6-1	50	929	1439	68.0
3/19/2015	71318	71294	B2:6-2	50	1242	1988	65.0
3/19/2015	53703	53729	B2:6-3	50	713	1165	65.5
3/19/2015	71339	75131	B2:6-4	50	134	574	32.1
3/19/2015	53683	71287	B2:5-1	50	1329	1512	91.2
3/19/2015	74346	71356	B2:5-2	50	157	1259	16.4
3/19/2015	48444	82282	B2:5-3	31	0	625	5.0
3/19/2015	71620	86383	B2:5-4	40	0	496	8.1
3/19/2015	71309	71329	B2:4-1	0	0	723	0.0
3/19/2015	71303	66223	B2:4-2	50	17	1128	5.9
3/19/2015	53642	53677	B2:4-3	50	885	1489	62.8
3/19/2015	74903	53634	B2:4-4	0	0	329	0.0
3/23/2015	71339	71294	B1:4-2	50	111	819	19.7
3/23/2015	71306	82535	B1:4-3	50	117	994	16.8
3/23/2015	53688	66223	B1:4-4	50	670	1587	45.4
3/23/2015	71360	71363	B1:3-1	50	307	652	54.8
3/23/2015	53703	71358	B1:3-2	50	302	691	50.9
3/23/2015	71304	53634	B1:3-3	50	267	1215	26.1
3/23/2015	84772	53672	B1:3-4	50	210	764	34.0
3/23/2015	71365	71350	B1:2-1	50	929	1838	53.3
3/23/2015	53683	87829	B1:2-2	50	451	721	69.5
3/23/2015	71372	87680	B1:2-3	50	105	280	55.4
3/23/2015	71369	71344	B1:2-4	0	2	749	0.3
3/23/2015	UNK	71329	B1:1-1	50	25	1110	6.8
3/23/2015	53662	71357	B1:1-2	50	765	1743	46.8
3/30/2015	71319	71373	A2:3-1	50	183	892	26.1
3/30/2015	86106	71312	A2:3-2	50	87	851	16.1
3/30/2015	71370	86438	A2:3-3	45	0	847	5.3
3/30/2015	71360	71287	A2:3-4	50	155	520	39.4
3/30/2015	74377	75131	A2:3-5	0	0	300	0.0
3/30/2015	71507	84047	A2:3-6	50	135	1466	12.6
4/6/2015	85490	82307	A2:2-1	0	0	507	0.0
4/6/2015	71299	53711	A2:2-2	50	256	756	40.5

Spawn Date	Female	Male	Tray	BS	Recovery	Total	Hatch %
4/6/2015	71321	53637	A2:2-3	50	391	824	53.5
4/6/2015	74371	83712	A2:2-4	0	4	406	1.0
4/6/2015	74385	52638	A2:1-1	0	0	706	0.0
4/6/2015	71354	66156	A2:1-2	50	1104	1699	67.9
4/6/2015	53716	71322	A2:1-3	50	445	963	51.4
4/13/2015	85600	81844	A1:5-1	0	0	619	0.0
4/13/2015	53936	53729	A1:5-2	0	0	906	0.0
4/13/2015	71495	71310	A1:5-3	150	0	1061	14.1
4/20/2015	71324	86383	A1:4-1	0	0	522	0.0
Totals				1,716	12,765	41,436	34.9

Appendix 4. 2015 Iron Creek Spawning Crosses

Spawn Date	Female	Male	Tray	BS	Recovery	Total	Hatch %
3/5/2015	82601	82439	E1:5-1	0	0	695	0.0
3/5/2015	82550	82502	E1:5-2	0	0	739	0.0
3/5/2015	82472	82535	E1:5-3	0	0	657	0.0
3/5/2015	82557	82565	E1:5-4	0	0	308	0.0
3/5/2015	81441	82435	E1:4-1	0	0	96	0.0
3/5/2015	74306	82499	E1:4-2	0	0	331	0.0
3/5/2015	82564	82561	E1:4-3	0	0	237	0.0
3/19/2015	82443	82549	B2:3-1	0	0	137	0.0
3/23/2015	82599	82483	B1:1-3	4	0	282	1.4
Totals				4	0	3,482	0.1

Appendix 5. 2015 Spruce Creek Spawning Crosses

Spawn Date	Female	Male	Tray	BS	Recovery	Total	Hatch %
12/12/2014	74358	74321	B2:1	0	0	119	0.0
12/12/2014	74307	74318	B2:2	0	0	106	0.0
12/12/2014	74293	74343	B2:3	0	0	108	0.0
12/12/2014	74292	74323	B3:1	0	0	144	0.0
12/12/2014	74345	74291	B3:2	0	0	206	0.0
Totals				0	0	683	0.0

Appendix 6. Stocking

FY2015

Date	Lineage	Location	State	Number	Length	Weight	Purpose	Stocking Purpose
10/1/2014	WC	Upper White Creek	NM	5,326	4.3	169	Recovery	Recovery
10/7/2014	SD	Grapevine Creek	AZ	288	4.3	9	Recovery	Recovery
10/7/2014	SD	Frye Creek	AZ	288	4.3	9	Recovery	Recovery
10/7/2014	SD	Frye Creek	AZ	104	10.3	46	Recovery	Recovery
10/20/2014	MD	Sheep Corral	NM	166	4.3	5	Recovery	Recovery
10/23/2014	MD	Black Canyon	NM	3,167	4.3	99	Recovery	Recovery
11/14/2014	SD	Willow Creek	NM	1,511	4.1	42	Recovery	Recreation
11/14/2014	SD	Willow Creek	NM	180	11.1	99	Recovery	Recreation
11/19/2014	MD	Little Creek	NM	2,052	4.3	65	Recovery	Recovery
5/28/2015	MD	Frye Mesa Res.	AZ	63	18.3	185	Brood	Recreation
5/28/2015	MD	Frye Mesa Res.	AZ	218	14.6	311	Brood	Recreation
5/28/2015	MD	Frye Mesa Res.	AZ	195	14.1	219	Brood	Recreation
6/2/2015	SD	Frye Mesa Res.	AZ	800	7.7	148	Recovery	Recreation
6/2/2015	MD	Frye Mesa Res.	AZ	17	19	57	Brood	Recreation
6/2/2015	SD	Frye Mesa Res.	AZ	65	18.9	197	Brood	Recreation
6/2/2015	SD	Frye Mesa Res.	AZ	220	14.9	344	Brood	Recreation
6/4/2015	SD	Willow Creek	NM	31	11.8	47	Brood	Recreation
6/4/2015	SD	Willow Creek	NM	83	12.7	83	Recovery	Recreation
6/4/2015	SD	Willow Creek	NM	495	7.7	92	Recovery	Recreation
6/10/2015	SD	Transfer to NMFWCO	NM	25	1.7	0.05	Recovery	Outreach

Totals 15,294 7.0 2,225

Appendix 7. Hatchery Data

Hatchery Data

Feed Conversions*

Lineage	Average Change in Weight per Fish	Period	Conversion	Average Length Change per Month
13MD	0.71	Aug 14-Aug 15	2.5	0.21"
14MD	0.41	Aug 14-Aug 15	1.7	0.52"
15MD	0.02	Apr 15-Aug 15	1.0	0.64"
13SD	0.78	Aug 14- Aug 15	2.1	0.24"
14SD	0.50	Apr14- Aug 15	1.9	0.55"
15SD	0.02	Apr 15-Aug 15	1.0	0.64"
14WC	0.38	Aug 14-Aug 15	2.3	0.43"
15WC	0.02	Apr 15-Aug 15	1.1	0.57"

*Broodstock only

Condition Factors (August 2015)

Lineage	Condition Factor (C)
13MD	0.000426
14MD	0.000431
15MD	0.0004
13SD	0.000427
14SD	0.000425
15SD	0.0004
14WC	0.000433
15WC	0.0004

Note: Data derived from length and weights during the fish health inspection. Wild Gila trout condition factor is $C = 0.00039$ (data from Jim Brooks of over 600 individuals).

Appendix 8. 2016 Spawning Plan

Mora National Fish Hatchery, 2016 Spawn Plan												
	Brood (Ttl #)	Adjusted Brood (Ttl #) 10% never spawn	Eggs/ Female	Total Eggs (Brood * 0.5 * eggs/ female)	Eye-up %	Eyed Eggs	Eyed to Age-0 Survival	Age-0 Fish	Brood Need	Recovery Request (Age 1)	Recovery Request (Age 0)	4(d) Age 0
Main Diamond												
Age 2	1050	945	400	189,000	17%	31,752	50%	15,876	-	-	-	15,876
Age 3	401	361	650	117,293	50%	58,529	50%	29,264	1,200	-	15,000	13,064
					Ttl MD	90,281		45,140	1,200	-	15,000	28,940
South Diamond												
Age 2	675	608	400	121,500	24%	28,917	50%	14,459	-	-	-	14,459
Age 3	330	297	650	96,525	49%	47,008	50%	23,504	600	-	7,500	15,404
Wild (Age 4)	122	110	900	49,410	49%	24,063	50%	12,031	600	-	7,500	3,931
					Ttl SD	99,987		49,994	1,200	-	15,000	33,794
Whiskey Creek												
Age 2	575	518	400	103,500	25%	25,875	50%	12,938	600	-	5,000	7,338
Wild (Age 5)	80	72	1000	36,000	35%	12,420	50%	6,210	600	-	5,000	610
					Ttl WC	38,295		19,148	1,200	-	10,000	7,948
Spruce Creek												
Wild (Age 5?)	106	95	200	9,540	25%	2,385	50%	1,193	1,193	-	-	-
					Ttl SC	2,385		1,193	1,193			
Iron Creek												
Wild (Age 4?)	32	29	600	8,640	25%	2,160	50%	1,080	1,080	-	-	-
					Ttl IC	2,160		1,080	1,080			
					Ttl All Stocks	233,108		116,554	5,873	-	40,000	70,682