REFUGIA WORK PLAN SUMMARY 2013-2017

- To meet EAHCP goals facilities must be constructed, equipped, and staffed.

- Construction and personnel additions must be able to meet standing stock, refugia and salvage contingency scenarios simultaneously.

- When production of plants and animals for restocking is not occurring and tank space is available the facilities will be used to advance propagation, life history, and restoration related research.

- EAHCP goals effectively double the number of organisms and aquatic holding/rearing systems at the San Marcos Aquatic Resources Center (SMARC).

- All buildings, at all facilities, will be metered for electricity and water use.

QUARANTINE BUILDING (2013 SMARC, UVALDE AND INKS DAM NFH):

- Organisms cannot be incorporated into the refugia without being placed in quarantine and approved for incorporation through Hazard Analysis and Critical Control Point Procedures and Fish Health inspections for pathogenic and parasitic organisms as is Service Policy (see *Service Manual Chapters, Series 700-Population Management Series for Service Policy and Directives*).

- Eliminate or minimize the risk of introducing viruses, bacteria, parasites, invertebrates, vertebrates, and plants into existing stocks held in refugia and other stocks that are not associated with Edwards Aquifer (see *Service Manual Chapters, Series 700-Population Management Series for Service Policy and Directives*). Refugia stocks should not be inadvertently exposed to lethal pathogens or parasites. In any hatchery setting densities are typically higher than those found in the wild. As a result, disease and parasite transfer rates can be quick, high, and lethal. Only organisms in good condition will be incorporated into refugia and subsequently restocked if needed. Holding any non-covered species will also negatively affect Covered Species though direct competition for space, food, etc. Holding and maintaining non-covered species is not required by the EAHCP and is not cost effective. In addition holding non-covered species may also negatively affect genetic management and propagation protocols by creating an illusion that more Covered Species are being held in refugia than are actually required. Proactive management of diseases, parasites, and non-covered species is more effective and less expensive than reactive management.

- Eliminate or minimize the risk of viruses, bacteria, parasites, invertebrates, vertebrates, and plants from inadvertently escaping and also minimizes the risk of out of basin transfer during restocking (*see Service Manual Chapters, Series 700-*

Population Management Series for Service Policy and Directives). Introducing non-native organisms into watersheds could create significant biological and potentially liability issues.

- Enables biologically secure examinations of the effects that exotic organisms and plants have on Covered Species at low flows as outlined in the EAHCP.

- Current quarantine systems at the SMARC are temporary structures, only treat limited amounts of water (<0.1 to 20gpm), empty into common drain system and are inadequate for current refugia goals and objectives. They have been effective but they are costly to operate and have limited capabilities. They will be ineffective at the flows required to met EAHCP goals and objectives.

- The proposed Quarantine Building will be ≈1,000 ft^2 (@ $250 to 300 per ft^2), equipped with an HAVC system, and at least eight 10x2x2ft insulated fiberglass tanks each equipped with an independent heater-chiller, pump, and degasser system.

- Quarantine Building effluent will be chlorinated to an appropriate concentration and maintained at this concentration for a given time before being discharged downstream of the facilities thereby preventing cross contamination of facility water.

- The Quarantine Building as proposed is equipped to have devoted space for each listed species simultaneously. However if species are brought on sequentially as opposed to all at once the Quarantine Building's systems could hold **either** 1,200 fountain darters **or** 1,200 salamanders until their transfer into refugia.

- During refugia and salvage triggers Quarantine Building space would likely be divided among species, dependent upon needs. Species are commonly held in isolation for up to 1-month or until cleared by Fish Health.

- Refugia collection numbers are currently based on the "50:500 Rule" (inbreeding/extinction) but in the near future will be based upon genetic analyses and modeling. Thus numbers could range between 500 and 5,000 individuals for each species. If this occurs space may be limiting within the Quarantine Building, particularly during salvage operations.

- If salvage triggers are reached, species and river conditions will be used to prioritize the use of space and determine the number of individuals collected for each species.

REUSE SYSTEM (2014 SMARC):

- The Service committed funding to a reuse system more than ten years ago. As a result the reuse systems foundation, building, plumbing, and electrical system are complete; however, due to delays in construction the Federal funding was not sufficient to complete the system. The system is not equipped with ozonation, CO^2, temperature, and standby power supply systems.

- The SMARC is mandated to minimize use of Edwards Aquifer Water and will strive to increase and/or maximize reusable water capabilities (see *Biological Opinion for Edwards Aquifer Use by San Marcos National Fish Hatchery and Technology Center and Uvalde National Fish Hatchery* [Consultation No. 21450-2010-F-0066]. Additionally Federal Agencies must identify and implement water savings conserve and protect water resources through efficiency, reuse, and recycle, measures to achieve a reduction of water use by the end of fiscal year 2015 (see *Presidential Executive Orders 13514 and 13423* codified by the Omnibus Appropriations Act 2009).

- EAHCP goals effectively double the number of organisms and aquatic holding systems at the SMARC. As a result, water use will effectively double to an average of 400 ac-ft per year. The reuse system increases productivity per unit of water input. The reuse system would significantly reduce water usage to at an estimated 40 ac-ft per year. This is based on the assumption that the SMARC would only require 10 to 20% make-up water due to evaporation, spillage etc.

- The reuse system provides flexibility for refugia particularly in lieu of any changes or additions that may occur through the EAHCP Adaptive Management Process. Currently the SMARC uses an average of 200 ac-ft per year of its permitted 566 ac-ft per year. If the SMARC doubles its capacity to 400 ac-ft per year it will result in only a 100 gpm reserve for alternate and future water use.

- The reuse system is also important given future projections of water use and availability. As water becomes more expensive and less available the value of reuse system will increase. Reductions in water use provide greater predictability of costs and reduce vulnerability to utility price volatility. Given the population growth projections for Central Texas there is a fair degree of certainty that water and utilities will increase in price as opposed to decrease.

- Reducing water requirements through conservation technologies and reclamation/recycling/reuse strategies is a core element of a sustainable facility. By minimizing water requirements, the facility is reducing the impacts on the entire water infrastructure including reductions in groundwater pumping, water treatment and its associated energy and chemical usage. The result is obtaining the most use from the least amount of water with the least impact, and may also

result in reducing or eliminating the need for development of additional costly water resources in the future.

- The reuse system increases the SMARC's ability to provide functional refugia for all Covered Species by providing flexibility given the uncertainty that exists regarding regulatory agency and Service policy on water use and pumping. The SMARC has experienced at least three scenarios and has had two different regulatory agencies determine pumping limits.

- The reuse system also acts as a back-up system that can continue to circulate water thereby maintaining populations during well pump failure due to mechanical, radio-link, and electrical failures.

REFUGIA BUILDING (2015-2016 SMARC):

- When flows are at critical levels the Refugia Building will be used to house and propagate standing, refugia, and salvage stocks. When flows are above critical levels the Refugia Building will be used to house standing stocks and conduct research on propagation, life history, and reintroduction methods.

- Refugia Building will be ≈6,000 ft^2 (@$250 to 300 per ft^2) and will be equipped with an HAVC system, and equipped with 40 (10x2x2ft) insulated fiberglass rearing tanks some of which will be equipped with independent heater-chiller, pump, and degasser systems.

- Additional square footage is critical since Covered Species collected at different sites or river segments are housed in separate systems (Table 1). This results in the need for an additional 30 rearing systems during refugia triggers and an additional 10 rearing systems, four raceways (existing) and six ponds (existing) during salvage triggers. The total number of new aquatic systems needed to meet EAHCP goals and objectives is a minimum of 40 aquatic systems.

Table 1. Estimated number of each species held at the SMARC at different EAHCP trigger levels. The number of rearing systems needed is based on collection sites and river segments as determined by USFWS Austin ESFO and TPWD. Estimated numbers of individuals per species are currently based on the "50:500 rule" and are subject to change with genetic analyses. The number of fountain darters to be collected during salvage exceed 500 because fish will be used to assess genetic change when pairwise mating schemes are not imposed.

Species	Current Standing Stock #s	Estimated Refugia Stock (broodstock #s needed)	Minimum # of rearing systems needed for Refugia stocks	Estimated Salvage stock #'s to be collected	Minimum # of rearing systems needed for Salvage stocks
Fountain Darter					
San Marcos	450	450	0	2,500	1
Comal	300	300	0	2,000	1
Texas wild rice	158	38	0	1,500	0
Comal Springs riffle beetle	38	462	2	500	1
Comal Springs dryopid beetle	0	500	2	500	1
Pecks Cave amphipod	1	500	3	500	1
San Marcos salamander	100	400	6	500	1
Texas blind salamander	54	446	13	500	1
*Comal Springs salamander	0	0	4	500	1
*Edwards Aquifer diving beetle	0	0	0	500	1
*Texas troglobitic water slater	0	0	0	500	1

*Petitioned species

- Currently three buildings hold standing stock for six of the ten Covered Species. The square footage that houses these six species totals 5,077. Given that EAHCP objectives double the number of organisms and aquatic systems an additional 6,000 ≈ft^2 of space devoted to refugia is needed. The current buildings and the respective ft^2 used for EA species are as follows:

Holding House (enclosed)	1,120 ft^2
Test Pad (enclosed	2,500 ft^2
Greenhouse (open)	1,457 ft^2
Total	5,077 ft^2

- Current buildings cannot hold required refugia and salvage stock for all Covered Species.

  Refugia stocks include an additional 750 fountain darters, 38 Texas wild rice pots, 462 Comal Springs riffle beetles, 500 Comal Springs dryopid beetle, 500 Peck's Cave amphipods, 400 San Marcos salamander, and 446 Texas blind salamander. Additionally, refugia stocks from different rivers and river segments are held separately. For example, fountain darters from the Comal River are held in different systems than San Marcos stocks. Progeny produced from refugia stocks from different rivers and river segments are reared in different systems.

  Salvage stocks require an additional number of individuals for all species plus additional rearing systems for the three Petitioned Species (Edwards Aquifer diving beetle, Texas troglobitic water slater, and Comal Springs salamander).

- The proposed Refugia Building, coupled with current square footage already being used, would enable the SMARC to hold a full complement of refugia specimens and some salvage stocks. For example with refugia stocks in place, within the proposed Refugia Building, and all research suspended the Refugia Building would have 10 insulated fiberglass tanks available for offspring production and/or salvage stocks. These 10 tanks could house **either** 1,500 fountain darters **or** 1,500 salamanders **or** a combination of species from the two rivers or various river segments.

- Current buildings do not provide tank space to simultaneously test and advance culture techniques and hold a full complement of standing, refugia, and salvage specimens. All research would be suspended during refugia and salvage efforts.

- Invertebrate refugia and salvage stocks must be housed indoors to avoid immigration of unwanted airborne organisms (diving beetles and riffle beetles).

- Although ponds and raceways will be evaluated for housing additional refugia and salvage stocks, genetic analyses needs to be done to insure their use does not adversely affect stocks genetically.

PERSONNEL ADDITIONS:

SMARC

2013 *Administrative Assistant (FTE, Term employee)*-Charged with tracking $1.68 million and expenditures for three facilities. This includes all accounting, procurement, expense tracking, and reporting for three facilities. Complete all expense reporting for the Service's Federal Business Management System and that required by the EAA. Assist Inks Dam and Uvalde NFHs with similar tasks as applicable.

Facility Operation Specialist (FTE, Term employee)-Assists with development of facility needs including preliminary design of new structures. Operates and maintains wells, reuse system, temperature control systems and alarm systems for all buildings, ponds, and raceways. Ensures that State and Federal regulatory compliance (e.g. NEPA, TCEQ etc.) is met. Assist Inks Dam and Uvalde NFHs with similar tasks as applicable.

Two Biological Technicians (FTE, Term Employees)-Charged with culture, propagation, and restoration work for Covered Species.

2017 Concurrent with construction completion

Supervisory Fish Biologist (FTE, Term employee)-Charged with culture, propagation, and hypothesis driven research for refugia organisms.

Up to Four Biological Technicians (FTE, Term employee)-Charged with culture, propagation, and restoration work for Covered Species.

Uvalde NFH

2013 *Biological Technicians (FTE, Term Employee)*-Charged with culture, propagation, and restoration work for Covered Species.

Inks Dam NFH

2013 *Biological Technician (1/2 FTE, Term Employee)*-Charged with culture, propagation, restoration work for Covered Species.

REDUNDANCY IN REFUGIA:

- Redundancy of off-site refugia facilities guard against unexpected loss of species in the wild. Examples include: catastrophic events such as the unexpected loss of spring flow, chemical spill, aquifer contamination, or other unforeseen catastrophic event.

- Redundancy of off-site refugia facilities guards against unexpected loss at a facility serving as refugia. Examples include: localized aquifer contamination, the loss of genetic integrity and diversity, mechanical failure, "acts of God" (e.g. fire, tornado, flood, hurricane, disease outbreak etc.), and human error.

- Redundancy guards against any unforeseen personnel changes, and policy change such as hatchery reprogramming, facility transfer, or closure as directed by Congress, Secretary of the Interior, or Service.

- A series of refugia will preserve the capacity for these species to be re-established.

- Cost for two additional refugia facilities excluding SMARC equates to an annualized cost of $125,420.

DIFFERENT SPECIES AT THREE REFUGIA:

- Working toward having a full complement of all listed species at two to three facilities.

- Species at each facility have been prioritized based upon the perceived species-specific affect of reduced river and spring flow. Those species that reside within the aquifer (e.g. Edwards Aquifer diving beetle, Texas blind salamander, Peck's cave amphipod, and Comal Springs dryopid beetle) as opposed to spring orifice (e.g. Comal Springs riffle beetle and San Marcos and Comal Springs salamanders) and river obligate species (e.g. fountain darter and Texas wild rice) are presumed to be affected last as flows decrease.

- Water source and quality differ among facilities.

- Current staffing levels and species-specific expertise vary among facilities.

- Only fountain darter, Texas wild rice, San Marcos salamander, Texas blind salamander, and Comal Springs salamander can be propagated and maintained with certainty.

- Some of the Covered Species are extremely rare in the wild or cannot be targeted for collection with certainty. For example, Texas blind salamander and some invertebrates are primarily collected when they are flushed out of the aquifer.