# 4.1 Long-Term Biological Goals and Objectives
**Summary and Highlights**

## 4.1.1 Biological Goals and Objectives

The identification of biological goals and objectives is one of five components outlined in the HCP Handbook Addendum (USFWS and NMFS 2000), referred to as the "5-Point Policy." (*See* Section 1.6.4). Long-term biological goals are the rationale behind the minimization and mitigation strategies and, conversely, minimization and mitigation measures are the means for achieving the long-term biological goals and objectives. The purpose of Section 4.1 is to establish the biological goals and objectives for the HCP based on the best scientific and commercial data available.

All long-term biological goals, accompanying management objectives, and flow-related objectives are subject to change under limited circumstances set out in the Funding and Management Agreement (FMA). Any such change will be based solely on the best scientific and commercial data available.

### 4.1.1.1 Comal Springs/River Ecosystem

**Fountain Darter**

***Long-term Biological Goals***

The long-term biological goals for the fountain darter at Comal Springs are quantified as areal coverage of aquatic vegetation (habitat) within four representative reaches of the Comal system (Upper Spring run [upstream most portion of the system to Spring Island], Landa Lake [Spring Island to the outflow to Old and New channels], Old Channel, and New Channel) and fountain darter density (population measurement) per aquatic vegetation type. The habitat-based and population measurement goals are presented in Table 4-1 and include proposed aquatic vegetation restoration efforts. The population measurement goal is to maintain the median densities of fountain darters observed per aquatic vegetation type per system at a level greater than or equal to that observed over the past 10 years in the EAA Variable Flow Study monitoring.

Table 4-1
Fountain Darter Habitat Aquatic Vegetation ($m^2$) and
Fountain Darter Median Density (Number/$m^2$) per habitat type

| Fountain darter habitat (aquatic vegetation) goal in meters squared (m2) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Study Reach | *Bryophytes* | *Hygrophila* | *Ludwigia* | *Cabomba* | *F.Algae* | *Sagittaria* | *Vallisneria* |
| Upper Spring Run Reach | 1,850 | 650 | 150 | | | 600 | |
| Landa Lake | 4,000 | 250 | 900 | 500 | | 1,250 | 13,500 |
| Old Channel | 150 | 200 | 1,500 | | 300 | | |
| New Channel | 150 | 1,350 | | 350 | | | |
| TOTAL | 6,150 | 2,450 | 2,550 | 850 | 300 | 1,850 | 13,500 |
| Fountain darter median density goal (Number/$m^2$ | | | | | | | |
| | *Bryophytes* | *Hygrophila* | *Ludwigia* | *Cabomba* | *F.Algae* | *Sagittaria* | *Vallisneria* |
| | 20 | 4 | 7 | 7 | 14 | 1 | 1 |

***Key Management Objectives***

The long-term biological goals are accompanied by two key management objectives needed to achieve the long-term biological goals. The management objectives for the fountain darter in the Comal Springs/River Ecosystem are (in no particular order):

- Active native vegetation restoration and protection will be implemented in Landa Lake and the Old Channel. Restoration activities will extend beyond the study reaches in equal proportion to effort expended per study area in relation to the total area of Landa Lake and Old Channel. For example, if 50 % of the Old Channel study reach was restored, 50 % of the entire Old Channel would be subsequently restored.

- Surface water quality within the Comal River should not exceed a 10 % deviation (daily average) from historically recorded water quality conditions (long-term average) as measured at the fifteen EAA Variable Flow Study water quality monitoring locations (Figure 4-1). This includes water quality constituents currently measured in the EAA Variable Flow Study except water temperature and dissolved oxygen.

- Note: This objective assumes that a 10 % deviation in average conditions would be acceptable; however, more extensive work to evaluate and assess water quality tolerances of the fountain darter will be addressed as part of the AMP. Water temperature and dissolved oxygen will be monitored and evaluated on an instantaneous basis within the four representative study reaches with established thresholds. Water temperatures <25°C will be maintained throughout the Comal system as to not inhibit fountain darter reproduction and recruitment over time. Dissolved oxygen concentrations > 4.0 mg/L will be maintained throughout fountain darter habitat.

***Flow-related Objectives***

The current level of uncertainty associated with the habitat-based long-term biological goals and the associated restoration and water quality management objectives necessitate the flow-related objectives in Table 4-2 of the EAHCP.

Table 4.2

Long-Term Average and Minimum Total Comal Discharge Management Objectives

| Description | Total Comal Discharge (cfs)[a] | Time-step |
|---|---|---|
| Long-term average | 225 | Daily average |
| Minimum | 30[b] | Daily average |

[a] Assumes a minimum of a 50-year modeling period that includes the drought of record.
[b] Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months.

## Comal Springs Riffle Beetle

***Long-term Biological Goals***

The long-term biological goals for the Comal Springs riffle beetle involve a qualitative habitat component and quantitative population measurement. As with the fountain darter, a representative reach approach was employed. From a habitat perspective, the goal is to maintain silt-free habitat conditions via continued springflow, riparian zone protection, and recreation control throughout each of the three sample reaches (Spring Run 3, Western shoreline, and Spring Island area). Additionally, the population measurement goal is to maintain greater than or equal to the median densities observed over the past six years of EAA Variable Flow Study monitoring.

***Key Management Objectives***

The long-term biological goals are accompanied by two key management objectives needed to achieve the long-term biological goals. The management objectives for the Comal Springs riffle beetle in the Comal Springs/River Ecosystem are (in no particular order).

- Aquifer water quality should not exceed a 10 % deviation (daily average) from historically recorded water quality conditions (long-term average) within the Edwards Aquifer as measured issuing from the spring openings at Comal Springs. This includes water quality constituents currently measured in the EAA Variable Flow Study. This objective assumes that a 10 % deviation would be acceptable. More extensive work to evaluate and assess water quality tolerances of the Comal Springs riffle beetle will be addressed as part of the AMP.
- Active restoration of riparian habitat adjacent to spring openings (Spring Run 3 and Western Shoreline) will be implemented to limit the sedimentation that is experienced following rainfall events.

***Flow-related Objectives***

The current level of uncertainty associated with the habitat-based long-term biological goals and the associated restoration and water quality management objectives necessitate the incorporation of flow-related objectives presented in Table 4-2.

**Comal Springs Dryopid Beetle and Peck's Cave Amphipod**

***Long-term Biological Goal***

The Comal Springs dryopid beetle and Peck's Cave amphipod are subterranean species inhabiting the Comal system. The subterranean nature and restricted range of the Comal Springs dryopid beetle (to the headwaters of the springs and spring upwelling areas) suggests that it does not require substantial surface discharge from springs to survive and presumes that springflow (of sufficient water quality) that continually covers the spring orifice should prevent long-term detriment to the population. EARIP (2009). Similarly, the Peck's Cave amphipod requirements include sufficient springflow covering the spring orifices and adequate water quality to prevent long-term adverse impacts to the species. (*Id.*).

As such, the long-term biological goal for these subterranean species focuses on Aquifer water quality as well as a springflow component. The water quality goal is:

- To not exceed a 10 % deviation (daily average) from historically recorded water quality conditions (long-term average) within the Edwards Aquifer as measured issuing from the spring openings at Comal Springs.
- This includes all water quality constituents currently measured in the EAA Variable Flow Study.

- Note: This goal assumes that a 10 % deviation would be acceptable; however, more extensive work to evaluate and assess water quality tolerances of these species will be addressed as part of the AMP.

***Flow-related Objectives***
The current level of uncertainty associated with the water quality long-term biological goal necessitates the incorporation of the flow-related objectives presented above in Table 4-2. Quantitative population measurements were considered for each species, but not established at this time for the following reasons:

- The Comal Springs dryopid beetle is infrequently captured and, thus, a population metric is not practicable with available data.
- Peck's Cave amphipods are collected in number, but a trend of increasing numbers of individuals with increased springflow is observed. The hypothesis is that as water movement through the Aquifer increases, more individuals are expelled through the spring openings and carried away from their livable habitat. A reduction in individuals expelling from the spring openings does not necessarily suggest a reduction in the quality of Aquifer habitat for this species.

As such, semi-annual drift net sampling for both species will be continued in the context of the AMP during Phase I, and this additional data will be evaluated with the intent of establishing population metrics for these species for Phase II of the HCP. Coupled with the water quality long-term biological goal, these flow conditions should provide habitat conditions and food supplies supportive of these Aquifer species.

### 3.6.3 Comal Springs Salamander (*Eurycea* sp.)

A population of salamanders occurs at Comal Springs, and for the purposes of this HCP we use the common name 'Comal Springs Salamander' that refers only to this population, in accordance with the federal listing petition for the species *Eurycea* sp. (USFWS 2009). This population was initially identified as *E. nana* (Sweet 1978), however Chippindale *et al*. (2000) confirmed these individuals were not *E. nana* but in fact a unique species. The morphology and genetics of this species is very similar to that of *E. neotenes*, and Bendik (2006) suggests that this "species" be synonomized with *E. neotenes* and the Comal collections be treated as a range extension. The USFWS (2009) has declared that substantial information was presented in the petition to indicate that the listing of this species may be warranted due to habitat loss or degradation resulting from numerous human factors including groundwater withdrawal and contamination.

A population of salamanders occurs at Comal Springs, and for the purposes of this HCP we use the common name 'Comal Springs Salamander' that refers only to this population, in accordance with the federal listing petition for the species *Eurycea* sp. 8 (USFWS 2009a and USFWS 2009b). The species is not currently listed as endangered, but may be listed in the future as FWS has made a positive 90- day finding in response to the petition.

***Habitat Requirements and Current Conditions***
The EAA Variable Flow Study has been collecting data on the Comal Springs salamander since fall 2000. (BIO-WEST 2002a-2011a). The range and locations of habitat in the Comal system is

similar to that of the Comal Springs riffle beetle but with somewhat larger areas and an extension upstream of Spring Island. Generally the habitat needs are similar to the San Marcos salamander which includes preference for silt-free rocks for cover, aquatic vegetation for cover and the support of invertebrate prey items, and a natural quantity and quality of water from the springs.

***Take Thresholds Relative to Springflow***

Similar to the Comal Springs riffle beetle, it is believed that take of Comal Springs salamander surface habitat begins to occur at approximately 120 cfs as a daily average at the main spring runs. Hardy (2009) documents that wetted area in the spring runs decreases between 150 and 100 cfs. Hardy (2009) predicts greater reductions in surface habitat in all three spring runs below 100 cfs. Additionally, there is no surface habitat predicted for Spring Runs 2 or 3 at a daily average of 30 cfs total discharge. (Hardy 2009). Although the modeling of surface habitat addresses changing conditions within the three main spring runs, it is important to reiterate that a large proportion of Comal Springs salamander habitat exists along the Western Shoreline of Landa Lake and at upwellings within Landa Lake. The spring upwelling areas in Landa Lake and the Western Shoreline will remain inundated at 30 cfs whereas Spring Run 3 would likely go subsurface except for near the terminus into Landa Lake.

### 4.1.1.2 San Marcos Springs

**Texas Wild-Rice**

***Long-term Biological Goal***

The long-term biological goal for Texas wild-rice has been determined by an evaluation of

1) the maximum occupied area of Texas wild-rice that has been present in the San Marcos system over time;
2) TPWD analysis of the Hardy (2010) physical habitat modeling; and
3) the 1996 USFWS recovery plan goals.

The long-term biological goal for Texas wild-rice is 14,451 $m^2$.

Table 4-10
Long-Term Biological Goal for Texas Wild-rice

| River Segment | Areal Coverage ($m^2$) | Reach Percentage of Total Areal Coverage |
|---|---|---|
| Spring Lake | 1,000-1,500 | n/a |
| Spring Lake Dam to Rio Vista Dam | 5,810-9,245 | 83-66 |
| RioVista Dam to IH-35 | 910-1,650 | 13-12 |
| Downstream of IH-35 | 280-3,055 | 4-22 |
| Total | 8,000-15,450 | 100 |
| | | |

***Key Management Objectives***

The long-term biological goal is accompanied by three key management objectives needed to achieve the long-term biological goal. The management objectives for Texas wild-rice in the San Marcos Springs/River Ecosystem are (in no particular order):

- Minimum Texas wild-rice areal coverage per segment during drought of record-like conditions (Table 4-11).

Table 4-11
Minimum Texas Wild-rice Areal Coverage per segment
During Drought of Record-Like Conditions

| River Segment | | |
|---|---|---|
| Spring Lake | 500 | n/a |
| Spring Lake Dam to Rio Vista Dam | 2490 | 83 |
| Rio Vista Dam to IH 35 | 390 | 13 |

- Recreation awareness throughout the whole river at all flows with designated control in the following high quality habitat areas below 100 cfs total San Marcos discharge.

- Active restoration and Texas wild-rice expansion efforts and long-term monitoring focused on high-quality habitat areas.

***Flow-related Objectives***
The long-term biological goals for Texas wild-rice are defined as areal coverage over a spatial extent of the San Marcos River (*see* Table 4-10). However, because of the uncertainty associated with the long-term biological goals, the associated management objectives necessitate the flow-related objectives presented above in Table 4-13.

## Fountain Darter

***Long-term Biological Goals***
The long-term biological goals for the fountain darter are quantified as areal coverage of habitat within three representative river reaches of the San Marcos system and fountain darter density (population measurement) per aquatic vegetation type. These habitat-based and population measurement goals are presented in Table 4-21. The population measurement goal is to maintain greater than or equal to the median densities observed per aquatic vegetation type per system over the past 10 years of EAA Variable Flow Study monitoring.

Table 4-21
Fountain Darter Habitat Aquatic Vegetation ($m^2$) and
Fountain Darter Median Density Number ($m^2$)

| Fountain darter habitat (aquatic vegetation) goal in meters squared (m2) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Study Reach | *Hygrophila* | *Ludwigia* | *Cabomba* | *Hydrilla* | *Potamogeton* | *Sagittaria* | *Vallisneria* |
| Spring Lake Dam | 50 | 200 | 25 | 100 | 1000 | 100 | 125 |
| City Park | 200 | 1000 | 50 | 500 | 2000 | 300 | 50 |
| IH-35 | 50 | 200 | 300 | 100 | 300 | 100 | 25 |
| TOTAL | 300 | 1400 | 375 | 700 | 3300 | 500 | 200 |
| Fountain darter median density goal (Number/$m^2$ | | | | | | | |
| | *Hygrophila* | *Ludwigia* | *Cabomba* | *Hydrilla* | *Potamogeton* | *Sagittaria* | *Vallisneria* |
| | 4 | 7 | 7 | 5 | 5 | 1 | 1 |

***Key Management Objectives***

The long-term biological goals are accompanied by two key management objectives needed to achieve the long-term biological goals. The management objectives for the fountain darter in the San Marcos Springs/River Ecosystem are (in no particular order):

- Active native vegetation restoration and protection will be implemented in all three representative study reaches. Restoration activities will extend beyond the study reaches in equal proportion to effort expended per study reach in relation to the total river segment. For example, if 50 % of the IH-35 study reach was restored, 50 % of the area from Rio Vista Dam to IH-35 would be subsequently restored.
- Surface water quality within the San Marcos River should not exceed a 10 % deviation (daily average) from historically recorded water quality conditions (long-term average) as measured at the water quality monitoring stations for the EAA Variable Flow Study. This includes water quality constituents currently measured in the EAA Variable Flow Study to be monitored per Section 5.7.2, excluding water temperature and dissolved oxygen. This objective assumes that a 10 % deviation in average conditions would be acceptable, however, more extensive work to evaluate the validity of that assumption and to assess water quality tolerances of the fountain darter will be addressed as part of the AMP. Water temperature and dissolved oxygen will be monitored within the representative study reaches and evaluated on an instantaneous basis with established thresholds. Water temperatures <25°C will be maintained throughout the San Marcos system as to not inhibit fountain darter reproduction and recruitment over time. Dissolved oxygen concentrations >4.0 mg/L will be maintained throughout fountain darter habitat.

***Flow-related Objectives***

The current level of uncertainty associated with the habitat-based long-term biological goals and the associated restoration and water quality management objectives necessitate the incorporation of flow-related objectives in Table 4-13.

Table 4-13
Long-Term Average and Minimum Total
San Marcos Discharge Objectives

| Description | Total San Marcos Discharge (cfs)[a] | Time-step |
|---|---|---|
| Long-term average | 140 | Daily average |
| Minimum | 45[b] | Daily average |

[a] Assumes a minimum of a 50-year modeling period that includes the drought of record.
[b] Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months.

**San Marcos Salamander**

***Long-term Biological Goals***

The long-term biological goals for the San Marcos salamander include a qualitative habitat component and a quantitative population measurement. As with the fountain darter and riffle beetle, a representative reach approach was employed. From a habitat perspective, the goal is to maintain silt-free habitat conditions via continued springflow, riparian zone protection, and recreation control throughout each of the three representative reaches (Hotel area, Riverbed area, and eastern spillway below Spring Lake Dam). Additionally, the population measurement goal is to maintain greater than or equal to the median densities observed over the past 10 years of monitoring.

***Key Management Objectives***
The long-term biological goals are accompanied by two key management objectives needed to achieve the long-term biological goals. The management objectives for the San Marcos salamander in the San Marcos Springs/River Ecosystem are (in no particular order):

- Aquatic gardening at similar capacity to what has occurred over the last 10 years in Spring Lake will be continued for the Riverbed Area. This is currently being coordinated and performed by Aquarena Springs personnel.
- Recreation control will be implemented in the eastern spillway below Spring Lake Dam, particularly at total San Marcos discharge of < 100cfs.

***Flow-related Objectives***
The current level of uncertainty associated with the habitat-based long-term biological goals and the associated vegetation and recreation management objectives necessitate the incorporation of the flow-related objectives presented above in Table 4-13.

**Texas Blind Salamander**

***Long-term Biological Goal***
Similar to the Comal Springs dryopid beetle and Peck's Cave amphipod, the Texas blind salamander is a subterranean species. An assumption of the HCP is that as subterranean species, mechanisms exist for these species to retreat into the Aquifer should springflows cease at the spring outlets at San Marcos Springs. As such, the long-term biological goal for this subterranean species relates to Aquifer water quality. The water quality goal for the Texas blind salamander is:

- Not to exceed a 10 percent deviation (daily average) from historically recorded water quality conditions (long-term average) within the Aquifer as measured issuing from the spring openings in Spring Lake.

This includes water quality constituents currently measured in the EAA Variable Flow Study. To be conservative, the long-term goal assumes that a 10 percent deviation would be acceptable; however, more extensive work to evaluate and assess the validity of that assumption and the water quality tolerances of the Texas blind salamander will be considered in the AMP.

***Flow-related Objectives***
The current level of uncertainty associated with the long-term biological goal necessitates the incorporation of the flow-related objectives presented above in Table 4-13. Coupled with the water quality goal, these flow conditions should provide habitat conditions and food supplies supportive of this Aquifer species.

**Comal Springs Riffle Beetle**

Due to the paucity of data for this species in the San Marcos system, it is not possible to establish specific long-term habitat-based biological goals. As such, the HCP assumes that the flow-related goals presented in Table 4-13 would be protective of this species, until such time as additional information is available. This is a reasonable assumption in that the Comal Springs riffle beetle inhabits similar areas to the San Marcos salamander with similar habitat requirements, and as such, protection of the salamander and its habitat coupled with water quality protection of the aquifer should similarly protect this species.

As part of the HCP long-term monitoring program, Comal Springs riffle beetles at San Marcos Springs will be monitored semi-annually over time with additional monitoring triggered by either high-flow or low-flow events as described in the EAA Variable Flow Study.