

## 2.0 ALTERED HYDROLOGY

### 2.1 OVERVIEW

Altered hydrology refers to any anthropogenic disruption in the hydrologic and fluvial processes in the river system (Rosenberg et al. 2000). Changes in the river function can have significant impacts on the habitat for riparian species (Sakaris 2013). Threats to habitat include changes in the amount and timing of stream flow (Dunne and Leopold 1978; Trimble 1997; White and Greer 2002), geomorphological changes like widening and incising (Trimble 1997; Modrick and Georgakakos 2014; Taniguchi and Biggs 2015), and the establishment and persistence of pollutants (Paul and Meyer 2001) and invasive species (Ficetola et al. 2007; Ficetola et al. 2010). Stream channels collect water, sediment, and pollutants from the entire watershed and are highly affected by upstream land uses, especially urbanization.

Stream flow can change drastically as a watershed urbanizes. The increase in upstream impervious surface prevents infiltration and generally reduces evapotranspiration (Dunne and Leopold 1978; Trimble 1997; McBride and Booth 2005). This leads to an increase in the amount of surface flow and ultimately an increase in stream flow. Urban runoff is also faster flowing than natural surface flow, resulting in a reduced time between precipitation and peak stream flow (Dunne and Leopold 1978; Ossola et al. 2015). Changes in the stream flow dynamics can impact the stream morphology and vegetation characteristics.

Dams and stream channelization can alter the riparian vegetation by disrupting the natural stream ecosystems (Sakaris 2013). Dams have varying effects on downstream rivers depending on the timing of water releases and the type of dam (top over v. stream level discharge). Concrete stream channelization can prevent or slow the erosion of the stream channel but removes usable stream habitat and reduces the water infiltration, which many riparian species depend on (Richardson et al. 2007).

### 2.2 ALTERED HYDROLOGY IN THE MSPA

In the MSPA, the main threats from altered hydrology include aseasonal flow, geomorphological changes to the stream channel, and vegetation community changes in the riparian system.

### **2.2.1 Aseasonal flow**

In urban watershed, there has been an increase in the overall stream flow of San Diego rivers. A study of Los Peñasquitos Creek demonstrated an increase in the minimum, median, and maximum flows from 1960 through 2000, with the minimum increasing faster than then median or maximum. In addition, the dry season runoff increased faster than the annual average, with only a slight increase in precipitation over the same period (White and Greer 2006).

Stream flow is significantly altered during the dry season due to the addition of water in the system from urban uses (Walsh 2000). Under natural conditions, San Diego streams occasionally dried completely during the summer, depending on winter precipitation (Brodie 2013; City of San Diego 2013). Instead, urban runoff from outdoor landscaping or other outdoor uses, creates a system that maintains flow year-round (called aseasional flow). This change has allowed for the persistence of invasive aquatic species like crawfish and bullfrogs (Ficetola et al. 2007; Ficetola et al. 2010).

### **2.2.2 Geomorphology**

Stream systems have also experienced a change in morphology due to urbanization. The expansion of impervious surface in the watershed increases the rate of channel erosion (Dunne and Leopold 1978; Trimble 1997). An increase in impervious surface concentrates the flow energy on the stream system, causing channels to increase in size. Channels can become either wider or deeper depending on a number of factors; see Sec. 2.3, Results of Altered Hydrology Studies, below.

### **2.2.3 Vegetation changes**

Vegetation changes have resulted from stream flow and geomorphological changes. Portions of Los Peñasquitos Creek changed from a broad and braided channel (1928 and 1945 aerial images) to an incised channel beginning in 1969 (White and Greer 2006). In the same reaches, the acreage and density of riparian vegetation increased from 1928 to 2000. Pieces of the stream that were visible from aerial imagery in 1945 were completely covered by vegetation in 2000. The increase in vegetation consisted mainly of willows growing in previously unoccupied stream banks (White and Greer 2006).

### **2.3 RESULTS OF ALTERED HYDROLOGY STUDIES IN THE MSPA**

Hydrological studies in the MSPA have focused on aseasonal flow originating from urban sources. The USGS recently began a several-year study to identify stream channels vulnerable to aseasonal flow and determine a threshold for the amount of urbanization that leads to a year-round flow (Brown et al. 2015). This study deployed 56 Stream Temperature, Intermittency, and Conductivity (STIC) loggers, which are sensors that record temperature and relative conductivity (water presence). An additional 64 STIC sensors have been placed in arroyo toad habitat in order to relate water presence with the presence of arroyo toads and invasive aquatics. Initial results indicate that there could be a positive relationship between urban areas and the number of days with water present in the stream (C. Brown, pers. comm., September 14, 2016).

Geomorphological studies have focused on the stream channel dimension's relationship to upstream urban and agriculture land uses (Dunne and Leopold 1978; Trimble 1997; Biggs et al. 2010; Tanaguchi and Biggs 2015). In 2015, 80 sites throughout San Diego County, with data from 2001 through 2014 were used to analyze the impact of upstream urbanization on stream channel size and dimensions (Tanaguchi and Biggs 2015). This research found that the majority of urban channels were enlarged, with sand-bedded channels enlarged mainly through incising, and experienced the largest increase in bankfull dimensions. This relationship is also influenced by the age of the development and the stream soil type, with sandy soils more likely to incise and cobbly soils more likely to widen.

### **2.4 MANAGEMENT AND MONITORING APPROACH**

The altered hydrology management and monitoring goal is to reduce the impact of urban runoff and aseasonal flow on the highest-priority MSP species and riparian habitat so that species can persist over the long term (>100 years) in areas upstream and downstream of urban land uses.

The approach for managing an altered hydrologic regime is divided into 2 parts: general and species-specific. General altered hydrology management objectives focus on management actions that benefit natural resources across the MSPA and that are not targeted to particular species. Species-specific altered hydrology management objectives are developed for MSP species identified as at risk from altered hydrology, in which significant occurrences or even the species themselves could be lost from the MSPA as a result of an altered hydrologic regime.

### **2.4.1 General Approach Objectives**

Below is a summary of the management and monitoring objectives for the threat of altered hydrology. For the most up-to-date goals, objectives, and actions, go to the [MSP Portal Altered Hydrology summary page: http://portal.sdmmp.com/view\\_threat.php?threatid=TID\\_20160304\\_1449](http://portal.sdmmp.com/view_threat.php?threatid=TID_20160304_1449).

#### Continue USGS Research Using STIC Sensors

Management for aseasonal flow should be directed by continued monitoring of STIC sensor locations. This study should focus on identifying the relationships between watershed size, percent of watershed urbanized, and the number of days with stream flow. The analysis could also consider water temperature changes and the presence of invasive species.

#### Prepare a Comprehensive Hydrologic Management Plan

The results of the STIC analysis should be used in a comprehensive management plan. The plan should include identification of areas vulnerable to aseasonal flow, priority channels with covered MSP species at risk, and management actions to reduce the water flow or the damages caused by the change in water flow.

### **2.4.2 Species-specific Approach Objectives**

Descriptions of altered hydrology management approach and rationale, and the goals, objectives, and actions for at-risk MSP species are presented in the corresponding species sections. Links to species-specific altered hydrology objectives are provided in Table V2B.2-1. Use the MSP Portal for the most updated list of species with Altered Hydrology objectives.

**Table V2B.2-1. MSP plant and animal species with specific altered hydrology management and monitoring objectives.**

Scientific Name	Common Name	Management Category	Goals Objectives Actions Page Link
<i>Atriplex coulteri</i>	Coulter's saltbush	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=20523&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=20523&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Atriplex parishii</i>	Parish brittle scale	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=20554&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=20554&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Centromadia parryi</i> ssp. <i>australis</i>	Southern tarplant	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=780715&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=780715&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Eryngium aristulatum</i> var. <i>parishii</i>	San Diego button-celery	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=528066&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=528066&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Fremontodendron mexicanum</i>	Mexican flannelbush	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=21581&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=21581&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Monardella stoneana</i>	Jennifer's monardella	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=832834&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=832834&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Monardella viminea</i>	Willowy monardella	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=833060&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=833060&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Navarretia fossalis</i>	Spreading navarretia	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=31328&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=31328&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Orcuttia californica</i>	California orcutt grass	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=41970&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=41970&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Pogogyne abramsii</i>	San Diego mesa mint	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=32639&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=32639&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>

Scientific Name	Common Name	Management Category	Goals Objectives Actions Page Link
<i>Pogogyne nudiuscula</i>	Otay mesa mint	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=32643&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=32643&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Quercus engelmannii</i>	Engelmann Oak	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=19329&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=19329&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Branchinecta sandiegonensis</i>	San Diego fairy shrimp	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=624043&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=624043&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Euphyes vestris harbisoni</i>	Harbison's dunn skipper	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=707282&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=707282&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Panoquina errans</i>	Wandering skipper	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=706557&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=706557&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Streptocephalus wootoni</i>	Riverside fairy shrimp	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=624020&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=624020&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Anaxyrus californicus</i>	Arroyo toad	SO	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=773514&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=773514&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Spea hammondi</i>	Western spadefoot toad	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=206990&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=206990&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Emys pallida</i>	Southwestern pond turtle	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=668677&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=668677&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Agelaius tricolor</i>	Tricolored blackbird	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179060&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179060&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>

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<i>Campylorhynchus brunneicapillus sandiegensis</i>	Coastal cactus wren	SO	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=917698&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=917698&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Empidonax traillii extimus</i>	Southwestern willow flycatcher	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=712529&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=712529&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Passerculus sandwichensis beldingi</i>	Belding's savannah sparrow	VF	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179325&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179325&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Vireo bellii pusillus</i>	Least Bell's vireo	SO	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179007&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=179007&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Antrozous pallidus</i>	Pallid bat	SL	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=180006&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=180006&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>
<i>Plecotus townsendii pallescens</i>	Townsend's big-eared bat	SO	<a href="https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=203457&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit">https://portal.sdmmp.com/tracker.php?Target=species&amp;Species=203457&amp;MonMgtObjType=&amp;ActionStatus=&amp;ManagementUnit=&amp;ObjectiveType=&amp;Year=&amp;Preserve=&amp;Short=Long&amp;submit=Submit</a>

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