



United States Department of the Interior

NATIONAL PARK SERVICE

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To: Kristen Hase, Chief of Natural Resources, Tallgrass Prairie National Preserve (TAPR), KS.

From: (Carl) Nicolas Medley, Aquatic Ecologist/Fisheries Biologist, Aquatic Systems Branch, WRD-NRPC-WASO-NPS, Fort Collins, Colorado

Re: Stream hydrology and geomorphology, and fish habitat restoration at TAPR

Date: May 14, 2014

Summary

The streams of Tallgrass Prairie National Preserve (TAPR) are an example of a well-documented channel evolution, caused by a combination of river channelization and straightening leading to channel incision and tributary head-cutting, and the historical impacts of severe over-grazing. The impacts of channelization are difficult to correct, but in areas where natural grade control does not exist, it may be necessary to install grade controls to prevent further incision and create the conditions necessary to allow a stable stream configuration to form. While present stock densities are much reduced compared to historic densities, the continued grazing impacts are still sufficient to greatly retard the natural recovery of the spring-fed prairie streams typical for the region. Generally, only complete rest from grazing, through fencing, or other intensive cattle management practices are likely to result in restoration of the natural hydrologic and geomorphic processes sufficient to restore some attributes of normal stream function. It is the standard management practice in such situations and is the only one likely to be successful in a time frame that is relevant to the timely conservation of the shiner. Given the dependence of the Topeka shiner on these habitats within TAPR, it is recommended that cattle grazing be eliminated from those streams that are essential to the survival of the shiner on the Preserve, and to be intensively managed in other areas to promote stream restoration.

Introduction

Restoration of the native fish community within TAPR requires an understanding of the natural riverine habitat that is important in the life history of these fishes, the natural ecological processes that create and maintain it, and an understanding of past and present management activities that may have impacted it. Resource managers must understand how these streams functioned prior to settlement, how it likely responded to past land management, and the sequence of events that has created the current condition of the river. Only then can limiting factors for the native fish community be identified, and specific, targeted management actions be developed to restore riverine habitat and address fisheries management issues.

This memorandum provides a brief summary of the primary habitat and ecology issues that are of most relevance to the conservation of Topeka shiner and restoration of aquatic habitat within TAPR, and proposes specific best management practices to correct them. It primarily draws on the river classification scheme developed by Dave Rosgen. While other classification schemes have been developed, I have chosen to use this one because it is now widely used, it is easy to find useful reference materials, and several papers have been

published that use this classification system, that specifically address the stream erosion and degradation issues evident at TAPR. The reader can familiarize themselves of the classification system and its use by referencing the following materials:

Applied River Morphology. 1996. Dave Rosgen. Director, Wildland Hydrology, 1481 Stevens Lake Road, Pagosa Springs, CO 81147

A Geomorphological approach to restoration of incised rivers. David L. Rosgen. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision, 1997. S.S.Y. Wang, E.J. Langendoen and F.D. Shields, Jr. (eds.) ISBN 0-937099-05-8.

Stream Processes: Part 1: Basics. Stream Processes. Zaimes, G., and Emanuel, R. 2010.

Channel Processes: Stream Channel Succession, USEPA.
<http://water.epa.gov/scitech/datait/tools/warsss/successn.cfm>

Primary Issues

There appear to be two primary issues that must be addressed if long term conservation of the Topeka shiner, and the native aquatic community, is to be successful within TAPR; 1) restoring some semblance of natural stream geomorphology and the habitat attributes that are required by the shiner, and 2); management and removal of non-native fish species that may compete or hybridize with, or predate on native fish.

Geomorphology

The spring fed tributary streams originating within TAPR are home to a diverse and abundant native fish community well adapted the ecosystem. The type and abundance of aquatic habitat available for a fish to live is dependent upon channel form, which provides the primary physical framework within which it lives and evolves. Understanding the fundamental relationships between riverine habitat, the processes that create and maintain it, and the ecology and life history requirements of the native fish community is essential for developing effective restoration strategies. However, historical land management activities and changes in watershed condition greatly altered the physical and biological processes that formed the natural riverine habitat in which this community flourished. Only by restoring the natural processes that created the habitat vital to the health of the native fish community, can a persistent and self-sustaining native fish community be maintained and/or restored.

The form of a river channel (cross section, planform, longitudinal profile) and how it relates to its adjacent floodplain is determined by a suite of interacting, fundamental variables; valley slope; the magnitude, duration, frequency, timing and variability of flows; the quantity and size of available sediments and; local and regional constraints that affect the rate at which a river can erode its banks and migrate laterally across the valley floor (e.g. underlying geology, bedrock outcrops, shoreline vegetation and manmade structures such as bridges and bank reinforcements). These variables may change naturally from year to year, but over long periods of time, they vary and interact in a predictable way. It is the long term balance between these fundamental variables and the dynamic equilibrium around a most probable state that determines a rivers characteristic form. If any of these controlling variables change, the balance will shift and the river will evolve towards a new configuration with a new characteristic form.

These geomorphic adjustments in stream type may happen slowly in response to long-term climatic or geological changes. Alternatively, they may occur quickly in response to sudden changes in land management and watershed condition causing a stream to evolve through a characteristic series of stream channel adjustments in response to rapid changes in hydrology, sources and types of sediments and local constraints. Contemporary stream channels are often in one of the intermediate stages of degradation or recovery as they

continue to adjust from the impacts of historical land use. Piecing together the exact sequence of events that led to the current state of the channel requires information from a variety of sources and historical accounts and photographs often make it easy to document. In some regions of the U.S. the impacts of land management and the subsequent changes in channel form are so well documented that it is possible to describe the exact sequence of events that led to the current state of a stream. Such is the case within TAPR.

The following description of channel types and changes that have occurred within TAPR relies on the stream type classifications developed by Rosgen. While other stream classification schemes are available, Rosgen's is relatively simple and reference materials are widely available. Additionally, the description of stream types, the evolutionary stages of channel adjustment that occurred at TAPR and the general description of the causes is well documented in his book; *Applied River Morphology* (Dave Rosgen. 1996. *Wildland Hydrology*), which should be consulted as a primary source.

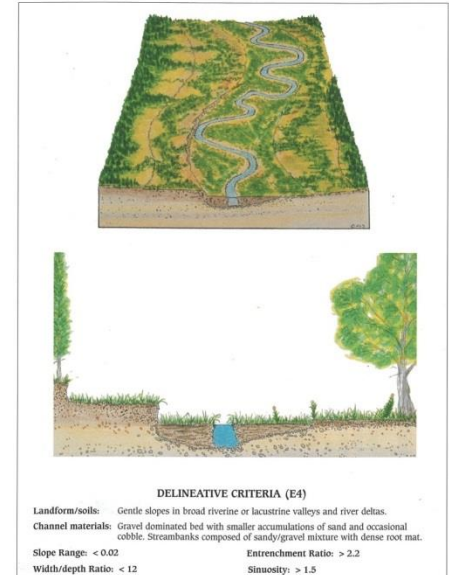
Historic TAPR Streams

Before significant human influence, the small, prairie spring fed streams in the vicinity of TAPR were generally narrow, deep, single thread channels that meandered through a relatively wide, alluvial floodplain. The channels were narrow, with high, stable banks composed of fine sediments stabilized with deep rooted grass-like herbaceous wetlands vegetation and prairie grasses. The spring water would have been extremely clear and the river bed clearly visible. The substrate was predominantly gravels with areas of smaller sands and some larger cobbles, that would have been light (almost white) in color due the precipitation of marl (calcium carbonate) with large areas of green submerged aquatic vegetation. Accordingly the stream was historically a Rosgen E3 and E4 stream type.

Rosgen (1996) describes the E4 stream type:

The E4 stream types are channel systems with low to moderately sinuosity, gentle to moderately steep channel gradients, with very low channel width/depth ratios. The E4 type is a riffle/pool stream found in a variety of land forms including high mountain meadows, alpine tundra, deltas, and broad alluvial valleys with well developed floodplains. The E4 stream channels are found in valley types VIII, X, and XI. The E4 stream type exhibits predominantly gravel sized bed materials, with channel slopes less than 2%; however, they can also develop with slopes of 2-4% (E4b). Due to the inherently stable nature of the bed and banks, this stream type can develop with a wide range of channel slopes. Sinuosities and meander width ratios decrease, however, with an increase in slope. Streambanks are composed of materials finer than

that of the dominant channel bed materials, and are typically stabilized with extensive riparian or wetland vegetation that forms densely rooted sod mats from grasses and grass like plants, as well as woody species. Typically the E4 stream channels have high meander width ratios, high sinuosities, and low width/depth ratios. The E4 stream types are hydraulically efficient channel forms and they maintain a high sediment transport capacity. The narrow and relatively deep channels maintain a high resistance to plan form adjustment which results in channel stability without significant downcutting. The E4 stream channels are very stable unless the stream banks are disturbed, and significant changes in sediment supply and/or streamflow occur.



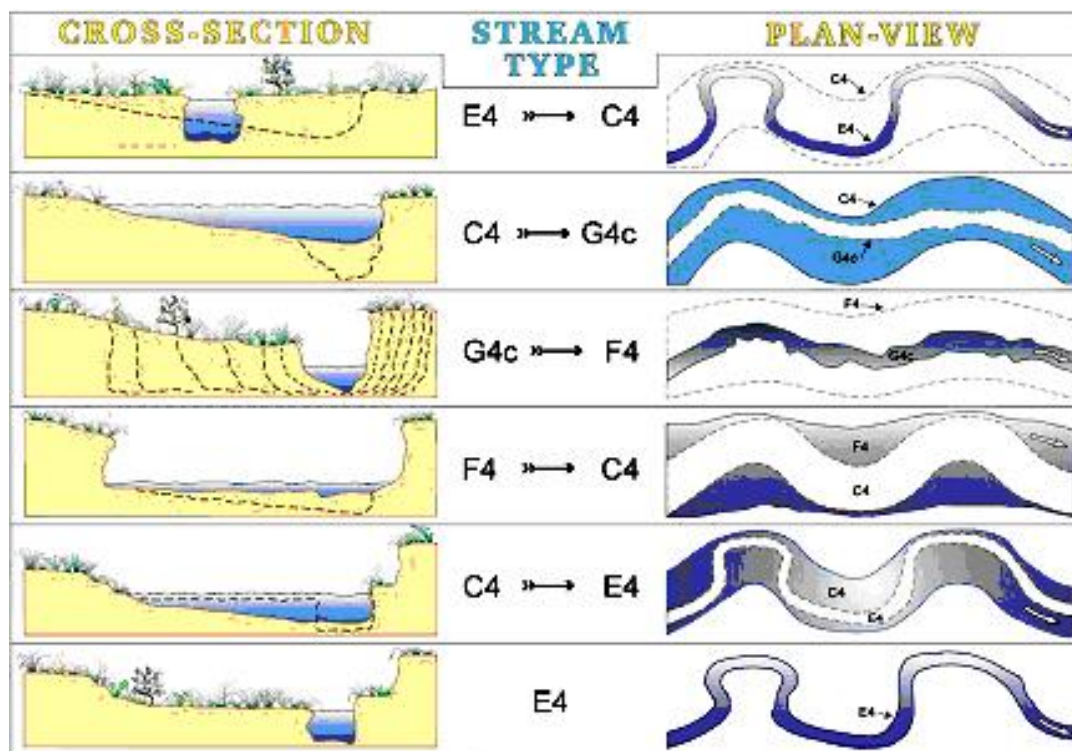
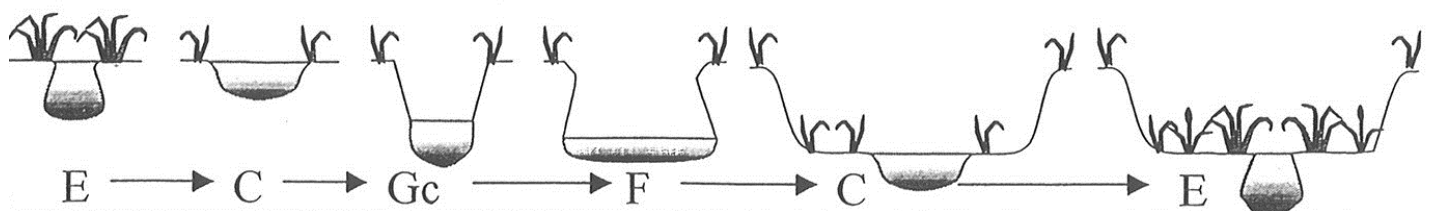
Watershed and Channel Evolution

The degradation of E3/E4 channel types within TAPR is almost certainly similar to that documented in countless other watersheds throughout the American West. In fact, it is such a commonplace occurrence, that numerous papers have been written on the evolutionary sequence of stream channel adjustments and the approaches that may be used to restore them. E stream types are very stable if left undisturbed. However, they may evolve rapidly in response to changes in streambank stability, sediment supply and hydrology. The history

of ranching and farming in the Flint Hills suggests that the primary causes of stream degradation were severe impacts of excessive cattle grazing, and perhaps stream channelization.

Beginning in the middle of the 19th Century, cattle reduced vegetative cover in both the upper watersheds and the floodplain and severely trampled streambanks. Watershed disturbance decreased the infiltration capacity of the soil and increased the frequency and magnitude of channel forming flows. Reduced streambank stability and increased flows caused severe watershed and streambank erosion, greatly increasing the availability of sediment, that then caused the river to widen, aggrade, and migrate laterally across the floodplain (C). Increased migration led to channel avulsions which shortened the length of the river and steepened the river channel. The increased slope of the channel initiated an episode of severe channel incision that lowered the elevation of the channel bed and caused abandonment of the historical floodplain (G). The subsequent inability of flood flows to dissipate their energy by flowing onto the floodplain promoted further channel bank erosion and widening (F). If the factors that initiated the first episode of channel widening and incision are not addressed, the cycle of channel widening and incision can recur numerous times, until further downcutting is prevented by natural grade control such as bedrock. A recent geomorphic condition assessment (Watershed Institute, 2010) confirms that at least some of the lower reach of Gashouse Creek is currently a broad C type stream within the wider incised channel, and much lower than its historic elevation.

Likely Stream Type Evolution Scenario (from Rosgen) at TAPR:



At the same time that TAPR stream channels were adjusting due to the watershed scale effects of severe cattle grazing (downcutting), lower stream reaches within TAPR (e.g. Fox Creek) were likely adjusting due to the effects of stream channelization working their way upstream (headcutting). Straightening and shortening of main stem river channels (e.g. Cottonwood River, Fox Creek), and the subsequent drop in the elevation of the controlling channel bed, led to the initiation of tributary rejuvenation; the process whereby lowering of a downstream elevation control initiates upstream erosion of all tributary stream channels. Eventually all streams that are not protected by an elevation control in their upper reaches will incise, and the entire watershed will reach a new lower, equilibrium elevation.

Inspection of the stream channels within TAPR suggests that many are suffering from the effects of both processes. While the magnitude of each process at each stream is different due to the site specific occurrence of attributes that control each process, every small stream in TAPR is now characterized by severe bank erosion, a lowering of the streambed elevation and the local ground water table, and disconnection of the stream from the historical floodplain (evolution to G and F stream types).

Spring Flows

Concurrent with the larger watershed degradation, spring flow likely decreased due to increased runoff and the reduction in water infiltration in the severely impacted grassland root system. Additionally, many major springs within TAPR were captured by the construction of stock tanks. There are currently 26 tanks within the Preserve. Further, the widening of the channel and loss of riparian shading increased water temperatures and evaporative losses of spring flow. While the quantity of spring flow was always relatively small and likely unimportant in influencing the observed channel changes, historically, it was absolutely essential for providing a small base-flow for the native fish, especially during times of drought.

In a functioning stream system that was narrow and deep, with high stable banks, and overhanging grass, the interaction between this small flow and the stream structure created extremely high quality habitat (deep narrow stream channels, cool, clear, spring water, clean gravel streambed, shade from overhanging vegetation), within which fish could survive in even the most extreme droughts. In such times, it was likely that there was very little surface flow, and the aquatic habitat was maintained by intersection of the stream bed with the ground water table. With the loss of the spring flows, and the incision and widening of the channel the small amount of spring flow is now insufficient to provide permanent habitat, and now, in many years, the habitat goes dry.

The important take home message is that the absolute quantity of spring flow is perhaps not as important as the interaction of some flow with the stream habitat structure that was historically present. It is restoring this habitat that is most important; as long as there is sufficient water to keep the streambed wet, whether or not it is flowing or just intersecting the ground water table, the native fish will likely persist. However, restoring spring flows will provide a much greater hedge against stream drying, especially in the degraded channel conditions currently occurring within TAPR.

Channel Restoration

Restoring E type stream channels is not an easy task. Stopping tributary head-cutting is only possible if the original downstream controlling elevations are restored, either through restoration of the historical channel form or the establishment of artificial grade controls (see Priority 1 restoration practices in Rosgen, 1997). This approach is expensive, time consuming and generally unrealistic, but perhaps not necessary if the primary goal is restoration a natural channel form without restoring the historic stream elevation.

The cheaper approach is appropriate management of the entire watershed and stream bank areas, to allow the reestablishment of natural hydrologic and geomorphic functions through intensive management of those activities that historically caused such changes. This will allow the slow restoration of the historic natural channel form (E) in tributary spring streams, but the stream reaches will reform at a lower elevation than their

historical elevations (see Priority 2 restoration practices in Rosgen, 1997). Consequently the water table will remain lower, and the lateral extent of historical floodplain will likely be diminished. However, in those areas where the Preserve has control over the entire upper watersheds, there is a very high likelihood that a stable stream channel can be recreated that will provide excellent habitat for native fishes on TAPR.

In the case of TAPR, the primary watershed impact was the historic, long term grazing of cattle at densities and locations that the land could not sustain without severe changes to the watershed hydrology and streambank stability. Accordingly, the primary restoration approach is the intensive management and/or complete cessation of grazing in those watersheds that require restoration.

No/Lower grazing pressure will restore the health of the grassland root system. More water will infiltrate into the ground causing increased spring flow. Vegetation, not continually nibbled and eaten by cattle is allowed to grow in wetted areas. Increased channel roughness and reduced water velocities in vegetated areas will trap available sediments. The reduction or elimination of cattle will reduce stream bank trampling and chiseling by sharp hooves. Slowly, stream banks, and an adjacent floodplain will rebuild, eventually recreating a stable stream channel. The process starts slowly, but once the stream conditions have improved to promote the reestablishment of natural fluvial processes, restoration can occur rapidly. Eventually, the restoration of the geomorphic processes that create and maintain appropriate stream channel form will also create the habitat needed for the protection and conservation of the Topeka shiner, and the native fish community.

Even with intensive management of grazing, it is likely that in the future, some areas of the stream will benefit from active restoration. For example, deeply incised stream banks on the outside of a river meander, where riparian vegetation cannot become easily established, may need to be layed back and the stream bank rebuilt, to stop stream bank erosion and lateral migration.

References

2010 Fluvial Geomorphology Assessment Report. Tallgrass Prairie National Preserve. 2010. Watershed Institute, Inc, Topeka, KS.

Possible approaches to Topeka shiner habitat restoration at TAPR

General Restoration Strategies

- Watershed restoration approach to reduce down-cutting: *work from upstream to downstream*
- Grade control restoration to prevent further head-cutting or restore historic elevation of river channel: *work from downstream to upstream*
- Passive restoration practices (grazing management) should be implemented as the first priority and given plenty of time to work
- Active restoration should be applied to areas that do not respond to passive restoration; eg laying back deeply incised stream banks on the outside of a river meander, where riparian vegetation cannot become easily established, to stop stream bank erosion and lateral migration.

Restore natural channel form through watershed and riparian restoration

- Reduce stocking rates dependent upon forage availability and range condition necessary to protect natural hydrologic and geomorphic function
- Remove stock tanks in drainages with shiner populations to restore natural stream flow and geomorphology
- Manage preserve by watershed, not pastures and roads. Priority watersheds; Gas House Creek, School House Creek, Tributary of Gannon Creek, 24 Middle
- Remove/modify culverts that are an impediment to movement and prevent natural hydrologic and geomorphic function
- Create small off channel habitats for Topeka shiner
- Create temporary fencing to exclude cattle from sensitive riparian areas adjacent to occupied stream reaches

Cattle Management

- Restructure pastures based upon watersheds rather than current pasture system. Reuse fencing material
- If necessary, consider permanent fencing to exclude cattle in spring sources and streams with known TS populations
- Reduce stocking rates dependent upon forage availability and range condition (drought) necessary to protect natural hydrologic and geomorphic function
- Employ rider to move cattle around and away from riparian areas
- Consider need to reduce stocking duration or go to fast rotation to reduce impact
- Construction of alternative water sources other than stock tanks on ridgelines and divides to disperse and move cattle away from riparian areas

Possible Cattle Management Practices

- Fencing of springs
- Riparian fencing to create permanent exclosures
- Creation of small riparian pastures for high intensity, short duration grazing
- Patch burn management
- Removal of cattle from pastures that contain watersheds important to native fish
- Reduction in grazing intensity
- Transition to Bison
- Use of Range rider
- Use of invisible electric fencing and cow collar

Restore Spring Flow

- Restore/manage vegetative cover in the upper watersheds to promote water infiltration and slow runoff to reduce peak, and channel forming flows
- Remove, or modify (put in pipes that maintain historic structure but allow spring flow to pass through dam) cattle tank dams that capture spring flows
- Remove non-vegetation from spring sources
- Replant with native wet meadow if appropriate

Management of Native Fish

- Implement NPS PMIS 133454 to create refugial populations in stock tanks in drainages not in current TS populated drainages that were historically connected to upstream spring habitats
- Restore Topeka shiner populations to historically occupied habitat on Preserve. Create through Section 10j (non-essential experimental populations) if necessary
- Remove cattle access to spring sources that are potential Topeka shiner refugia areas during drought (remove cattle from all unmodified spring sources??)

Remove non-native predatory fish

- Actively remove non-native fish species from stock tanks, tributary streams, and creeks where necessary to protect Topeka shiner
- Remove/modify stock tanks in drainages with shiner populations to remove source of non-native predators
- Review fishing regulations and the current “catch and release” of non-native predaceous fish in stock tanks on TAPR to ensure that they are not counter to Topeka shiner protection

Fire Management

- Implement fire management on watershed scale, not defined by pasture fencing or roads
- Manage fire frequency based upon natural cycle and timing to promote habitat restoration,
- Use patch-burn practices to encourage cattle to stay off stream areas important for Topeka shiner conservation

What does TAPR looks like now (May 2014)?



Typical watershed at TAPR, showing evidence of severe erosion and downcutting from historic and current grazing practices.



Gashouse Creek showing evidence of severe bank erosion, streambed incision, and subsequent widening, to form G, F and C type channels. Historically, it is unlikely that there were many trees in the drainage. They are a recent artifact of hydrologic and geomorphic changes that promote their establishment, and the lack of fire in those areas.



Lower reach of Gashouse Creek, showing evidence of streambank erosion, incision and subsequent widening to form an F type channel. The layers of gravel show the original elevation of the stream bed as it meandered across an alluvial wetland floodplain and indicate that the stream channel was likely 2-3 feet deep.



Middle Gashouse Creek exhibiting characteristics of an F Type channel that has the potential to evolve to a C and then an E type channel, if the right bank can be stabilized by the growth of streambank vegetation. This recovery is tenuous and the stabilizing vegetation can be lost in response to a high flow, or cattle disturbance.



Lower Gashouse Creek. C type channel



Spring flow in Middle Gashouse Creek, where there is little interaction between the available flow and streambank structure that can create fish habitat.



Middle Gashouse creek. The inability of the stream to move laterally against the bedrock protected hillslope, has allowed the creek to narrow and stabilize. This is probably what the majority of Gashouse Creek would look like in the near future if best management practices were put in place to promote stream restoration. The woody riparian vegetation is not representative of the historic natural condition, but is an intermediate step towards full recovery. It that will take many years to rebuild a fully functional floodplain with wetland vegetation, but this is a good intermediate condition that will provide good fish habitat.



Lower Schoolhouse Creek below HW177 bridge. While the vegetation, and the location, is not representative of the historic channel form, the stream habitat at this location shows that initial stabilization of the stream, and a little base flow can still provide excellent fish habitat and shows that establishment of this intermediate stage of recovery is an appropriate short-term goal for streams at TAPR.



Evidence of severe headcutting and channel incision in a tributary of Fox Creek. This “tributary rejuvenation” indicates severe incision of Fox Creek and the Cottonwood River as a consequence of historical channel straightening and shortening. Headcutting will travel upstream into the upper reaches of the basin, unless grade control is present to stop it. Such headcutting is evident within many of the headwater streams within TAPR.

What did TAPR look like historically?

The following examples are of small spring systems, some that currently possess Topeka shiner, that show attributes of their natural channel form and are representative of stream habitats that would historically have been found within TAPR.

Small volume spring stream: Montana



Citation for data on this website:

Small Volume Spring Stream. Montana Field Guide.

Retrieved on May 12, 2014, from http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=1640

General Description

This ecosystem is found in the Montana Foothills and Valleys Ecoregion. Elevation is 1200-2000 m. These small volume spring streams (average wetted width 1.3 m, >1 and <5 L/sec, average summer temperature <15°C, S003m-Warm springs - will have water temperatures >25°C) have moderated permanent flow with strong seasonal variability. Waters are mineral-rich and circumneutral to alkaline with pH of 7.0-8.2; clarity is often high. These factors contribute to lush growth of submerged aquatic vegetation, which may include watercress *Nasturtium officinale*, *Potamogeton* spp., and *Myriophyllum* spp. These streams represent groundwater discharge input, therefore they do not experience severe flooding or drastic temperature shifts and have more constant flow. The substrate of these streams is usually cobble riffles, gravel/sand runs and pools, with extensive beds of aquatic vegetation, and, unless they are degraded by cattle, flow silt-free and clear.

Diagnostic Characteristics

The S003 ecological system could be fishless because of its small volume and limited accessibility to a colonization pool of fish, and small warm springs (S003m) may be too warm to allow fish colonization. If present, the spring creek fish community historically had native species including westslope cutthroat, mottled sculpin, longnose dace, with Yellowstone cutthroat trout in the Yellowstone drainages. However, the introduced brook, brown, and rainbow trout tend to dominate and become the focal species of these systems. Abundant populations of spring creek macroinvertebrate communities are diagnostic because of the stable environment, but display relatively limited diversity. This fairly unique, low-diversity community consists of a combination of members from the Medium Coolwater Transitional, the Traditional Trout Stream, and the Foothills Transitional Assemblages. The community is dominated by the mayflies (*Tricorythodes* and *Ephemerella* spp. [usually *Ephemerella inermis* and *E. infrequens*]), the amphipod crustaceans (*Gammarus* and *Hyaella*), and many genera of Chironomidae. Other community indicator species include *Baetis tricaudatus*, caddisfly species (*Hydropsyche*, *Amiocratus asplis*, *Cheumatopsyche*, and *Brachycentrus occidentalis*), beetles (*Optioservus* spp.), and snails (*Gyraulus*, *Physella*, *Stagnicola*, and Hydrobiidae). An S003 spring near Townsend, Montana (Bedford's Spring) is home to an endemic springsnail of the genus, *Pyrgulopsis*, one of the only places this genus is found east of the continental divide.

Range

The Spring Creek type has been identified in the foothill and valley ecoregion of many Montana drainages, particularly some of tributaries to larger valley streams: Bedford Spring Creek, Ben Hart (tributary to the E. Gallatin), O'Dell Creek (tributary to the Madison), Warm Spring Creek of the Missouri drainage.

Spatial Pattern

Linear

Environment

Surface topography usually has a moderate gradient but can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters as well as their natural variability will have a corresponding effect on spring biological ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.

Management

Livestock use around the riparian areas is common and can have strong local effects resulting in sedimentation and streams becoming wider or shallower. High-density cattle usage can cause severe degradation, sedimentation, and siltation on the riffle habitats and gravel spawning areas downstream.

Northwestern Great Plains Intermittent Stream



Citation for data on this website:

Northwestern Great Plains Intermittent Stream. Montana Field Guide. Retrieved on May 12, 2014, from http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=1450

General Description

This ecological system is widely distributed throughout the coulees, small streams (1st to 3rd order) and headwaters of Medium Prairie Rivers (B005) and Great Plains Prairie Streams (C005) within the Northwestern Great Plains Ecoregion. These are small, warm-water, low to moderate gradient and elevation (900-1200m) intermittent streams. Stream sections in the moderate gradient reaches (riffles/runs) are the first to lose flowing water connections and become interrupted pools (D005). Once these systems lose their connectivity to fish recruitment pools of downstream reaches (this may be due to climatic factors such as prolonged drought) they become fishless isolated pools (E005). Throughout their range, these clear to turbid streams are characterized by short to long (~2-25m) pools that are sometimes vegetated with silted gravel to cobble substrates. The fishless pool community type provides substantial amphibian breeding and rearing habitat in otherwise harsh, dry upland conditions, so *Bufo* spp. (toads), Boreal Chorus Frogs (*Pseudacris* spp.), Tiger Salamanders (*Ambystoma tigrinum*), and *Rana pipiens* (northern leopard frog) tadpoles and adults are usually present. The E005c is a prairie stream reach within 1 river mile of a confluence with a larger river (at least 2 stream orders larger) and contains a biological fish community that is significantly affected by the large river connectivity.

Diagnostic Characteristics

The E005 ecological system type will be fishless. **(Maybe?? Nic comment).** Intermittent stream pool indicator species rely on seasonal pools as essential habitat. These species, sometimes also referred to as obligate species, are dependent upon these unique pools for their continued existence. One of the defining characteristics of the seasonal pool biotic community is a lack of permanent populations of predatory fish. Isolation and periodic drying keep predatory fish from colonizing and occupying the pool. This reduced-predator environment allows amphibian larvae and invertebrate larvae to thrive. Different species of amphibian and invertebrate seasonal pool indicator species occur across the Northern Great Plains Steppe of the United States. In Montana and northwestern North and South Dakota, amphibian indicators include Woodhouse's toad (*Bufo woodhousii*), boreal chorus frogs, spadefoots (*Spea bombifrons*) and tiger salamanders (*Ambystoma tigrinum*). These amphibians depend upon seasonal pools for optimal breeding. Additionally, a crustacean group, the fairy shrimp, *Branchinecta* and *Eubranchipus*, the clam shrimp *Caenestheriella*, and the tadpole shrimp *Lepidurus* rely on these pools for their entire life cycle. The diagnostic community of intermittent prairie stream invertebrates consists of the Prairie Pool assemblage (#12, Stagliano 2005). The community indicator species are characterized by tolerant, damselfly taxa (*Coenagrion*/*Enallagma*, *Lestes* and *Ishnura*), the crustaceans (*Hyalella* and *Gammarus*), many genera and species of the water boatman (*Corixidae*: *Sigara alternata*, *Trichocorixa nais*, and *Corisella*), the snails (*Physella*, *Gyraulus*, and *Stagnicola*), mayflies (*Caenis* and *Callibaetis*), and beetles (*Oreodytes*, *Laccophilus*, *Hydroporus* and *Hygrotus*). As the complexity of the pool habitat decreases the clinger habitat species are lost, such as the damselflies and many of the water boatman taxa.

Range

In Montana, the Northwestern Great Plains Intermittent Stream Ecosystem occurs throughout the non-glaciated Great Plains regions of northern North America within the Missouri and Mississippi River Drainages. Within Montana, this community exists in a multitude of streams and coulees mostly situated south of the Missouri River and within the Yellowstone River basin. Some of the many examples include Upper Otter, Bear, Hanging Woman, Trail, East Fork Trail, East Fork Hanging Woman, and Little Pumpkin Creek.

Dynamic Processes

Intermittent stream pool indicator species rely on seasonal pools as essential habitat. These species, sometimes also referred to as obligate species, are dependent upon these unique pools for their continued existence. One of the defining characteristics of the seasonal (intermittent) pool biotic community is a lack of permanent populations of predatory fish. Isolation and periodic drying keep predatory fish from colonizing and occupying the pool.

Management

Small stock ponds, dams, and cattle intrusions have had the most significant negative impact on this community. Anywhere stock ponds and dams occur the downstream reaches are affected by altered water temperatures and flow, and changes in sediment and nutrient transport (Winston et al. 1991). The spring flows backed up behind stock pond dams could have potentially filled numerous E005 pools, and possibly connected these pools for a brief period to downstream fish populations for recolonization. Therefore, unless there is sufficient outflow, streams and coulees below stock ponds usually do not develop this community type. Another threat to this

community is cattle intrusions, which cause trampling of stream banks with the subsequent siltation and nutrient inputs into the pools. This siltation and nutrient loading may eliminate aquatic macrophytes and cause blue-green algae blooms.

Early summer Kansas Prairie and Stream

Location unknown



<http://www.surfaceandsurfacephotography.com/2012/06/early-summer-kansas-prairie-stream/>

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South Dakota spring fed stream

<https://gfp.sd.gov/wildlife/management/plans/topeka-shiner-plan.aspx>



Prairie stream habitat in Minnesota

http://hatch.cehd.umn.edu/research/fish/fishes/topeka_shiner2.html



Habitat

One of the earliest descriptions of Topeka shiner habitat appears in Evermann and Cox (1896), where they report taking the species in "pond-like, isolated portions of streams which dry up in parts of their course during dry weather." They characterize the ponds as clear and cool with spring seeps, "an abundance of water vegetation", and "mostly soft mud" bottoms. There is no other detailed description until that of Minckley and Cross (1959), who studied the species in eastern Kansas. They found Topeka shiners "almost exclusively in quiet, open pools of small, clear streams that drain upland prairies." The streams typically were "a series of large pools . . . connected by short riffles and smaller pools; their flow [was] usually less than five cubic feet per second" and their bottoms "predominantly gravel, with some rubble and sand." They noted that "[i]n summer, the pools often develop plankton blooms, but rooted aquatic vegetation is uncommon." This species occupied "riffles only when . . . exceptionally abundant" and was "rarely found in streams that maintain a continuously strong flow" and was "not found in streams that are muddy and highly intermittent." However, "many of the streams . . . approach intermittency in summer" but the "pools are maintained at fairly stable levels by percolation through the gravel or by springs." Cross (1967) largely reiterated the above and added that "[p]robably many western streams provided this kind of habitat prior to plowing of the prairie sod."

Pflieger (1975) confirmed similar habitat characteristics for populations in Missouri, noting that extant populations were "largely restricted to direct tributaries of the Missouri River having sufficient gradient to prevent extensive deposition of silt." While such characteristics may be preferred by this species and apparently was typical of Kansas and Missouri populations, we now know that, in the northwestern portion of its range, Topeka shiners commonly occur in periodically turbid waters whose sand, gravel or rubble bottoms are covered by 5 cm or more of silt and detritus (Michl and Peters 1993; Elsen 1977). Further, we have discovered that Topeka shiners often are far more abundant (catches often greater than 100 individuals) in off-channel oxbows and excavated pools than they are in main channel pools and runs (Dahle 2001; Hatch 2001). Sampling in similar habitats in northwestern Iowa has produced similar results, which further have been linked to morainal deposits of the Des Moines Lobe (Clark 2000). Seasonal studies of these habitats in Minnesota have shown that Topeka shiners can complete their entire life cycle in these habitats (Dahle 2001).

Prairie Stream habitat in Northwestern Nebraska: Headwaters of the Niobrara River

Mostly recovered but still too wide and shallow in many places. Considerable fines, but substrate is starting to coarsen up. Nic Medley

