Verde River Watershed Report Card

Methods report on data sources, calculation, and additional discussion

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Report Card Team

This report card was co-developed and co-produced by the University of Maryland Center for Environmental Science (UMCES) Integration and Application Network (IAN), Friends of the Verde River, The Nature Conservancy, and the US Forest Service.

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Goals and objectives

The Verde River Watershed Report Card was developed to track the condition of water, habitat, and communities within the Verde River Watershed. The report card is meant to be used as a tool for understanding problem areas in need of restoration or conservation effort, but it is also meant to serve as an outreach tool for use by managers and organizers to highlight particular issues of importance when communicating conservation and restoration with the public.

The report card was co-developed with stakeholders from around the Verde River Watershed. The selection of indicators reflects the values stakeholders have for the Verde with an emphasis on those values thought to be under threat. Some of the important threats identified were land use changes, groundwater pumping, overuse of resources, climate change, and human pollution. Vitality of communities in the watershed was also identified as an integral component of watershed health. To build a report card with these qualities, and one that is relevant to the goals and objectives of the broad set of stakeholders in the basin, the project team held a series of workshops in the basin between November 2018 and April 2019. Workshop participants identified Habitat, Water, and Communities as high-level values to consider for assessing watershed condition. Specific indicators were subsequently developed within each of these broad categories.

The Verde River Watershed Report Card is an initial assessment of watershed condition. The report card team recognizes that there are many improvements that can be made to the report card indicators, data sources, and methods. Improvements can be made as the process is repeated for future report cards without jeopardizing the ability to track change in watershed condition over time.

Development process

In the first workshop on November 13–14, 2018, stakeholders from around the watershed provided input on values and threats to the watershed and some of the most useful ways to indicate watershed condition. Indicator categories were conceptualized and smaller working groups for each of these were established. Following the workshop, a series of conference calls were conducted to further define indicators and identify relevant data sources. The University of Maryland Center for Environmental Science (UMCES), Friends of the Verde River, and The Nature Conservancy provided data analysis for each of the indicators once data was identified and obtained from providers.

A second workshop was held March 4, 2019, with the purpose of engaging down-stream water users in the Phoenix Metropolitan Area. These stakeholders were given the opportunity to express their values and perceived threats for the Verde River Watershed. Alignment between upstream and down-stream user values and threats was discussed, as were data sources available from down-stream users.

With the initial workshops complete, the report card team evaluated data availability for each proposed indicator. For some indicators, such as water quality, initial scoring methods were established. Unscored data sets thought to be useful to the report card process were organized and prepared for the next workshop. A third workshop was held April 4–5, 2019, which further refined indicators and identified critical thresholds.

Draft results were shared with the public at the second State of the Watershed Conference, held October 28-30, 2019, when more than 180 attendees were given the opportunity to provide feedback on Report Card results during field trips, plenary sessions, and breakout groups. The first ever Verde River Watershed Report Card was publicly released on February 18, 2020.

Sub-region determination

Watershed sub-regions were determined based on geographic features (such as geology or land use), hydrology (such as drainage basin size, water circulation patterns, water flow), and human geography. All sub-regions should ideally have enough sampling sites for results to be scientifically rigorous and provide consistent analysis.

Based on stakeholder discussions, sub-regions were identified that matched the stakeholder's conceptual model of the watershed. The regions for the report card were determined by combining twelve-digit hydrologic unit codes (e.g., HUC12s), which are watershed boundaries identified by the U.S. Geological Survey. These small watersheds are hydrologically linked and upstream and downstream watersheds are identified for each watershed. Therefore, for each region, watersheds were identified that led from the headwaters to the Verde River.

Figure 1: Seven sub-regions of the Verde River Watershed.

There are seven regions in the report card, from north to south named the Big and Little Chino, Upper Verde, Upper Verde Valley, Oak Creek, Lower Verde Valley, Wild and Scenic, and the Lower Verde. All waters in the region flow into the Verde River before flowing into the next hydrologic region. One region was slightly different in that it covered one entire tributary, Oak Creek. A set of seven polygons were generated for these regions and used throughout the project to select data for grading for each region.

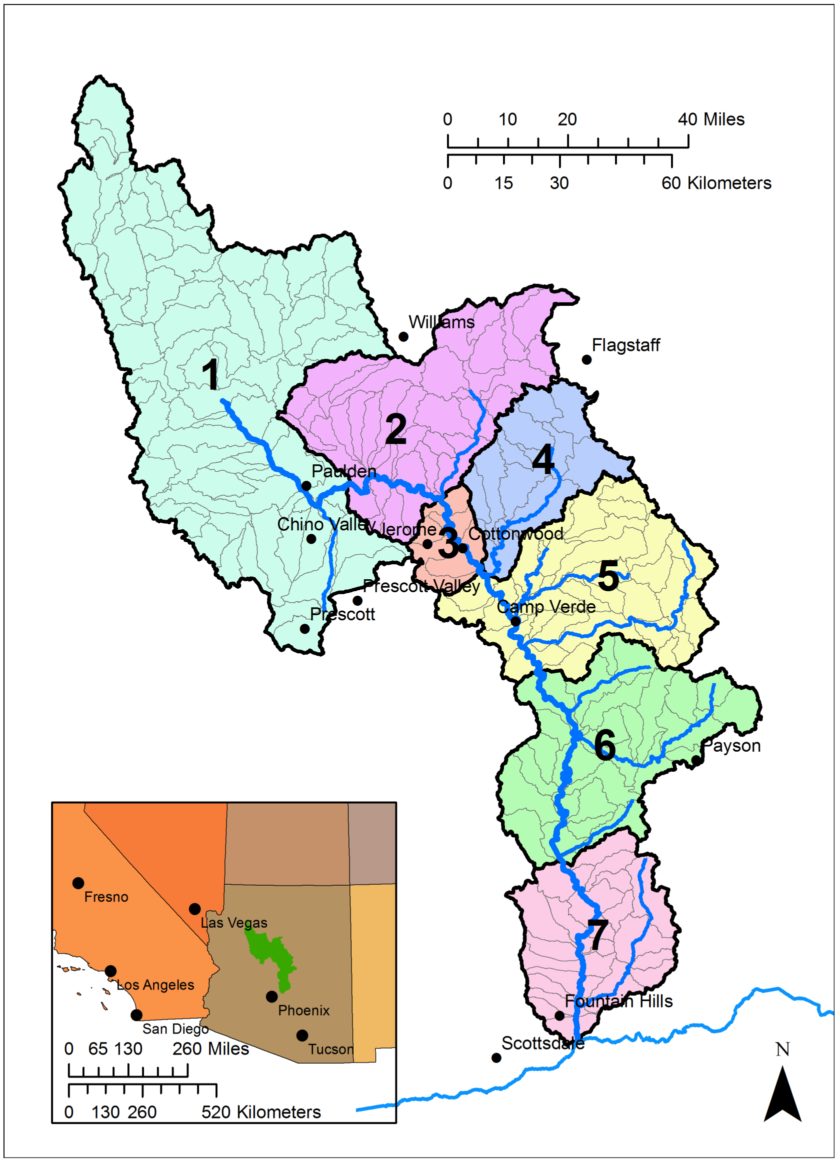

Figure 2: Seven sub-regions were created by combining HUC12 watersheds.

A second mapping dataset important to many of the indicators was a population layer. Population was provided by the U.S. Census Bureau at the block level. Census blocks are small polygons that scale in size based on population density. The boundaries of blocks span watershed and sub-watershed (region) boundaries. Therefore, we needed to downscale these data before calculating the population in each region. This was accomplished using Urban Imperviousness data from the National Land Cover Dataset (NLCD). The 2016 Urban Imperviousness data includes a data file called the Urban Imperviousness Descriptor, which identifies impervious pixels due to roads separately from other forms of impervious. Since roads are never homes and the population of an area can be somewhat independent from the amount of road surface, we removed all roads from the 2016 Imperviousness data. Then, for each census block, we took the total block population and distributed it over the remaining impervious area, distributing the population proportional to the amount of impervious in each grid cell. These data are provided at 30-m resolution, so this method results in an estimate of the population in each 30-m grid cell.

As described in the community indicators, this population layer enabled the weighting of different indicators by population. For example, if a Census Track (consisting of many blocks) spanned the boundary of the watershed, we assigned the estimated census statistic to the portion of the track population that was inside the watershed.

Indicators and thresholds

The indicators that had enough spatial and temporal resolution to use in the report card were baseflow, surface water BMPs, water quality index, water quality certainty, macroinvertebrates, turbidity, upland condition index, riparian birds, fish, affordable housing, unemployment, education, healthcare, digital engagement, civic engagement, recreation access, visitor satisfaction, and recreation planning.

Figure 3: Indicators for the Verde River Watershed.

Once these indicators were identified, targets or thresholds for each indicator were developed. Establishing targets for each indicator can be done by using pre-existing standard thresholds from the scientific literature or determining acceptable management goals. A threshold ideally indicates a tipping point where current knowledge predicts an abrupt change in an aspect or some aspects of ecosystem condition. Thus, from the perspective of choosing meaningful, health-related thresholds, this must be the point beyond which prolonged exposure to unhealthful conditions actually elicits a negative response, for the environment or human health. For example, prolonged exposure to dissolved oxygen concentrations below criteria thresholds elicits a negative response in aquatic systems by either compromising the biotic functions of an organism (reduced reproduction) or causing death.

More generally, however, thresholds represent an agreed-upon value or range indicating that an ecosystem is moving away from a desired state and toward an undesirable endpoint. Recognizing that many managed ecosystems have multiple and broad-scale stressors, another perspective is to define a threshold as representing the level of impairment that an environment can sustain before resulting in significant (or perhaps irreversible) damage.

When selecting thresholds, it is important to recognize that there are many already available, and more than likely, there are thresholds available for the indicator that is chosen. A good place to start looking for existing thresholds and goals is in other report card methods or scientific reports and publications.

One way to develop threshold values, if none exist, is to relate them to management goals. These goals can then be used to guide the selection of appropriate indicators. Even with the definition of agreed-upon thresholds, there is still the question of how best to use these threshold values in a management and governance context. Recognizing this challenge, thresholds can still be effectively used to track ecosystem change and define achievable management goals for restoration, preservation, and conservation of an ecosystem. As long as threshold values are clearly defined and justified, they can be updated in light of new research or management goals and can provide an important focus for the discussion and implementation of ecosystem management. Alternatively, if stressors are correctly identified and habitats appropriately classified, there should be multiple attributes (indicators) of the biological community that discriminate in predictable and significant ways between the least and most impaired habitat conditions. Reference communities can then be characterized using these data, which in turn can be used to develop threshold values.

For the Verde, there were several scoring methods that were applied for report card indicators, including:

1. **Pre-determined thresholds and scoring.** For some indicators, the data provider had already provided a rating of observations or results. These may have been measured against a regionally-specific desired condition or some other method. This method was used when the assessment methods were from an accepted source using generally accepted practices. In some cases, there was only one threshold provided; in these cases, the fraction of data meeting the threshold was used to generate a score.
2. **Comparison against a baseline condition.** For some indicators, a baseline condition could be established. For example, water quantity was graded against the mean and standard deviation of 7-day low flow conditions since 2006. These statistics (mean and standard deviation) were used to calculate a z-score, a quantitative parameter that describes how far above or below a value is from the mean, for the most recent year of data for each gage. The z-score was then divided up into five categories that represented the grades A through F.

Table 1: Example of grading against a reference distribution.

Description	Standard Deviation	Grade
substantially above national average	1.5 - 2.5	A
above national average	0.5 - 1.5	B
near national average	-0.5 - 0.5	C
below national average	-1.5 - -0.5	D
substantially below national average	-2.5 - -1.5	F

3. **Comparison to national average.** For the economic indicators, the basin was graded against the national average. Similar to #2 above, a z-score was used, but here the mean and standard deviation were calculated from county-level data throughout the country. The table below shows how the z-scores were translated into grades.

All measurements were standardized to a 0–100 scale to enable aggregation of individual indicators thematically up to the indicator categories, and spatially from regions to the entire watershed. Scores were distributed in even increments to enable ease of aggregation. It is important to note that the scoring scheme is not a reflection of a "curve" or a lenient grading system. The report card team (in consultation with diverse stakeholders) determined through data analysis what data values represented good and bad grades. Those were translated to the final scoring scheme and distributed into the 0–100 scale in 20-point increments. Therefore, final scores were given a grade as follows:

Score	Grade
80-100	A
60-80	B
40-60	C
20-40	D
0-20	F

Figure 4: Scoring scheme for the Verde River Watershed Report Card.

Water

Water indicators track both the quantity and quality of water in the watershed. They also track progress towards appropriate use of surface and groundwater best management practices.

Water Quantity

Indicator: Baseflow

Indicator importance: Baseflow is the flow in the river when it is not influenced directly by rain or snow and when it is most closely tied to flows from connected springs and aquifers. This gives an indication of the impacts from drought, climate change, and groundwater pumping. The Verde River is one of the last perennial rivers in the Southwestern United States, supporting one of the rarest forests in the world, the Fremont Cottonwood-Goodding Willow gallery forest. Without adequate flows, the Verde won't support these habitats.

Data source: United States Geological Survey (USGS), accessed via the web interface at https://waterdata.usgs.gov/nwis

Calculation method: Like all rivers, the discharge of the Verde River fluctuates rapidly in response to precipitation and snow-melt events. "Baseflow" is the term used to describe the flow during periods of low discharge (stream flow) between precipitation events. Baseflow is generally sustained by groundwater inputs along the length of the river and its tributaries. Perennially flowing springs are particularly important to Verde discharge in the upper Verde.

The full annual cycle of Verde discharge includes periods of generally high flow, with regular inputs of precipitation and runoff, and periods of generally low flow during seasonally dry periods. Through stakeholder discussions it was decided that the month of June generally contains the lowest discharge. June occurs after temperatures have been warm for several months. Evaporation and transpiration from vegetation have dried out the landscape significantly and discharge from snowmelt has already occurred. June is also before the summer monsoon season arrives in July-August. Therefore, this indicator uses USGS discharge data from the month of June.

There were long-term USGS gauge stations in five of the seven reporting regions (Table 2). The data used were observations from May and June over the entire period of record. The *7-day low flow* (minimum flow) was calculated for each 7-day period ending with the focal day in June. The *7-day low flow* was used because it is relatively insensitive to short-term peaks in discharge related to precipitation events that are shorter than a week. The mean *7-day low flow* was calculated for the month of June and was used as the indicator of baseflow conditions.

Baseline conditions were established for each gauge, against which each measurement of the June mean *7-day low flow* could be compared. Discharge at each gauge is unique based on its position in the watershed, therefore, baseline conditions for each gauge were established separately. An inspection of timeseries from each gauge suggested that baseflow has been declining for decades (Figure 5).

Stakeholders were generally comfortable stating that if current baseflow could be maintained, however,

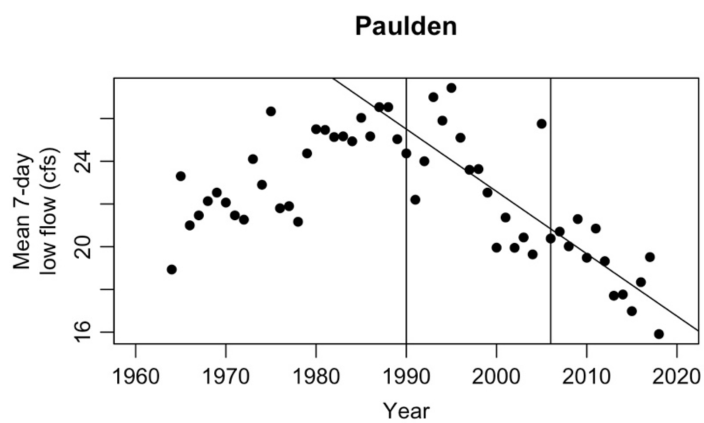

Figure 5: June mean 7-day low flow at Paulden gauge with a trendline fitted to data since 1990. The period since 2006 was adopted as the baseline period.

conservation efforts would be a success. The mean and standard deviation of the June mean *7-day low flow* were calculated between 2006 and 2018 and used as the baseline for each gauge (Table 2). We used these statistics to calculate a z-score for every June mean *7-day low flow*, and adopted the most recent two years (2018–2019) as the grading period. We scaled the z-score between -2.5 and 2.5, corresponding to grades from F to A. Therefore, where the 2-year June mean *7-day low flow* was above the baseline mean, the region received a grade above 50%. Likewise, when the 2-year June mean *7-day low flow* was below the baseline mean the region received a grade below 50%.

Table 2: Gauges and baseflow results.

June low flow (CFS)							
Gauge Name	**RC Region**	**Baseline Mean**	**Baseline StdDev**	**Recent 2 years**	**Grade**	**Trend**	**Trend p-value**
Paulden	2	19.1	1.6	17.7	33.1	-0.29	<0.05
Clarkdale	3	61.9	3.4	58.6	30.4	-0.82	<0.05
Oak Creek Sedona	4	27.3	1.4	27.8	56.8	-0.06	0.29
Camp Verde	5	51.1	13.2	44.9	40.6	-1.31	<0.05
Tangle Creek	6	84.9	18.0	67.8	31.0	-2.18	<0.05

Water Management

Indicator: Surface Water BMPs

Indicator importance: The Verde River is a hard-working river, supporting a wide variety of beneficial uses such as farming, ranching, and providing drinking water in the Phoenix Metropolitan Area. However, aging infrastructure and a lack of coordination between users can result in some users taking more water from the river than they need. This indicator measures the extent to which surface water users in a region have adopted practices and installed infrastructure that reduce unnecessary use of surface water.

Data source: The Nature Conservancy and Salt River Project

Calculation method: There are approximately 42 irrigation ditches in the Verde Watershed. These service between 1 to 1,000 water users each. There is no database of the irrigation ditches and their improvements. The following steps were taken to develop this indicator:

1. The Arizona Department of Water Resources GIS Layer of irrigation ditches was used to select ditches with more than three known users and associate each with a report card region based on location. This resulted in the identification of ditches in regions 3, 4, 5, and 7. These are the only regions that received a score for this indicator.
2. Three key best management practices were selected as evaluation criteria. A score from 0 to 10 was assigned for each criterion:

    a. Control Structure: 0 points for no primary head gate control structure; 5 points for a primary head gate control structure, 10 points for an automated head gate control structure.
    b. Flow Measurement: 0 points for no flow measurement device; 2.5 for stage plate flow measurements; 7.5 points for flow meters; and 10 points for flow meters with remote viewing capacity.
    c. Lining and Piping: 0 for no length of lined or pipe mainline of ditch; 2.5 for 1 to 20% lined or piped; 7.5 for 20 to 30% lined or piped; 10 for more than 30% lined or piped
3. The score from each of the criteria was added up (a total of 30 possible) and multiplied by the length of the ditch and summed by region.
4. The length of ditch evaluated in each region was summed. The score was normalized by length by dividing the total region score by the total length of ditch in the region.
5. The final score was converted to the 100% scale by multiplying by 3.33.

Indicator: Ground Water BMPs

Indicator importance: In Arizona, groundwater pumping is only regulated within regions that are termed Active Management Areas. Within the Verde watershed, there are two Active Management Areas, Prescott and Phoenix. Outside of these two Active Management Areas groundwater pumping in the watershed is largely unregulated. This is a threat to the future of the Verde River. In addition to groundwater pumping, the watershed lacks programs for augmentation of groundwater through infiltration or injection of stormwater or treated wastewater back into the aquifers from which water has been pumped. Much of the wastewater in the watershed is evaporated, rather than returned to the aquifer or river.

Future work: Groundwater is a critical component of watershed health as it supplies the vast majority of drinking water throughout the watershed. Municipalities, counties, and tribal entities are all taking steps to use groundwater more efficiently over time. This indicator will help us better understand practices across the watershed that can benefit the aquifer. At the time the report card was developed, however, not enough data was available to make a consistent analysis across the watershed. There is no publicly available record of groundwater use, for example. Therefore this indicator could not be scored and included in the current report card analysis. In the future it will be beneficial to measure the extent to which best management practices concerning ground water use have been implemented throughout the watershed.

Water Quality

Indicator: Water Quality Index

Indicator: Water Quality Index

Indicator importance: Good water quality in the Verde is essential to the communities, flora, and fauna that depend on upon it.

Data source: Arizona Department of Environmental Quality[1]

Calculation method: The Arizona Water Quality Index (WQI) is a tool developed to better communicate water quality information in a concise and understandable way to the general public, water quality professionals, and decision-makers. The WQI summarizes a set of water quality data from several chemical/ bacteriological parameters by using comparisons of the data to water quality standards. Evaluations are based on each reach's specific designated uses. The WQI generates a single standardized number reported on a scale from 0 to 100, with 100 representing the best water quality. The criterion for a top score is the uniform attainment of water quality standards applying to the reach under consideration. The general index considers the percentage of distinct chemical parameters exhibiting standard exceedances relative to the number of distinct chemical parameters, the percentage of results with standard exceedances relative to the total population of individual water quality results, and the magnitude of any excursion over the most restrictive water quality standard applying to the parameter considered (McCarty 2018).

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[1] The Arizona Department of Environmental Quality (ADEQ) provided water quality index values and index stability scores as a service to the Friends of the Verde River and the general public. ADEQ provides this information as-is, based solely on water quality data held by or internally available to ADEQ. ADEQ is not responsible for any errors or omissions that may occur in the data. Consumers of these data should be aware that ADEQ makes no representation that index values reported will necessarily corroborate current official Water Quality Assessment results and status. Users who wish to find more on the official assessment status of Verde waters and other Arizona waters, as well as assessment methodologies, are encouraged to visit the Surface Water Monitoring and Assessment page of the ADEQ website at https://azdeq.gov/programs/water-qualityprograms/surface-water-monitoring-and-assessment.

ADEQ makes no warranty or claim about interpretations of the health and safety suitability arising from the use of these indices. Any interpretations of the suitability of Verde waters for various aquatic activities or aquatic health are solely the responsibility of Friends and its affiliated partners and are not to be attributed to ADEQ.

Citations:

McCarty, D. 2018. The Arizona Water Quality Index: A Communications Tool for Water Quality Summaries. Arizona Department of Environmental Quality.

McCarty, D. 2019. Index Stability Score: An Adjunct tool for Water Quality Index Reporting. Arizona Department of Environmental Quality.

For the reaches of the Verde River watershed, data sets were comprised of core parameters evaluated by ADEQ in water quality assessments. Depending on the designated uses applied to a given reach, these included some combination of the following parameters:

- Dissolved cadmium
- Dissolved copper
- Dissolved zinc
- Dissolved oxygen
- pH
- Total nitrogen (if nutrient standards applicable)
- Total phosphorus (if nutrient standards applicable)
- Total mercury
- Total boron
- Total manganese
- Total copper
- Total lead
- Nitrate/nitrite
- Total arsenic
- Total chromium/chromium VI+
- Fluoride
- *E. coli*

If the reach was on ADEQ's 303(d) list of impaired waters, any impairment analytes were factored into the WQI calculation for that reach as well. In consultation with the Friends of the Verde, Verde watershed reaches were evaluated considering all data available to ADEQ in the five-year window from July 1, 2014 to June 30, 2019.

Reach scores were aggregated to regional scores for the Verde River Report Card by weighting the index score by the length of the reach in the region and summing the products. The final score was determined by dividing the sum by the total stream mileage evaluated in the region.

Citation: McCarty, D. 2018. The Arizona Water Quality Index: A Communications Tool for Water Quality Summaries. Arizona Department of Environmental Quality.

Indicator: Water Quality Certainty

Indicator: Water Quality Certainty

Indicator importance: Sampling water quality in a watershed as large and diverse as the Verde River Watershed is an enormous challenge. This indicator measures whether water quality samples in a given region were adequate to provide reliable assessments of water quality.

Data source: Arizona Department of Environmental Quality[1]

Calculation method: ADEQ has designed a corollary score to accompany the WQI. This score is termed an *index stability score.* The index stability score (ISS) is a score also on a scale from 0-100 calculating how stable and consequently reliable an expressed index value is considered. The ISS considers three distinct categories in its calculation: the statistical sufficiency of the set (i.e., average of records per parameter in the set), the natural variability exhibited in the set, and the data representativeness of the set. Included in the data representativeness metric are considerations of whether seasonality of data is well-distributed and whether both base flows and storm flows are represented in the set. Additionally, coefficients are included to govern the score in the case sample counts are below a threshold (for both the ISS and WQI), and to grade the percentage of analytes represented in the core parameter set (for the WQI).

As a quality assurance measure, index values that are modified to reflect their ungoverned values (i.e., leading coefficients dispensed with) lose their status as *water quality indices* and revert to consideration as *water quality scores***.** Scores are considered inherently more unstable and more subject to volatility as new data is added to the existing set; they are therefore considered less suitable for evaluation than index values meeting all quality assurance requirements. Data consumers should be aware of the distinction between water quality scores and indices, and scores should be considered with a greater degree of caution. Due to the limited set sizes of the agreed-upon five-year window for Verde River WQI calculations and the removal of the governing coefficients, WQI values used in the Verde River Report Card are *water quality scores*.

Reach stability scores were aggregated to regional stability scores for the Verde River Report Card by weighting the score value by the reach mileage lengths in the region and summing the products. The final score was determined by dividing the sum by the total stream mileage evaluated in the region. For more details see McCarty (2019).

Indicator: Macroinvertebrates

Indicator importance: Benthic macroinvertebrates are freshwater organisms that live in streams and on river bottoms. The abundance and diversity of these organisms are good indicators of local stream health because they have more limited movement than fish and they respond quickly to environmental stressors.

Data source: Arizona Department of Environmental Quality

Calculation method: The provided data were the results of surveys of stream benthic (bottom dwelling) macroinvertebrate species made since 1992. From the survey results, an Index of Biotic Integrity (IBI) was calculated by ADEQ for each survey site. Two methods were used to calculate the IBI, one for warm water sites located below 5000’ elevation and a second for cold water sites above 5000’ elevation. For the report card, all survey sites within the Verde River Watershed were identified and extracted from the database. The majority of samples in the Verde River Watershed were collected from reporting regions 4, 5, and 6. After the first two years in the record, the number of samples collected each year declined from ~150 samples/year measured at ~80 stations to 0-30 samples measured/year at ~20 stations. If we had restricted the sampling to the most recent year (2018), there were 22 samples across 19 stations and no samples from region 3 (Verde Valley). The observation period was extended to 2013, which provided 37 samples collected across 27 stations, including one station in the Verde Valley. This analysis suggests sampling is needed in regions 1, 3, and 7.

For each station, we identified the most recent survey that passed the criteria used by ADEQ to validate a sample for assessment purposes. Criteria used were that the sample was made (1) during the spring index period (Warm-water sites: April-May; Cold-water sites: May-June), (2) in riffle habitat, (3) in a perennial stream, (4) on mixed substrates (not bedrock or travertine dominant), and (5) during baseflow conditions. When these criteria were not met, survey results were flagged and removed from the analysis.

The IBI values were scaled to match the report card scoring methodology. The IBI values were provided on a 0-100 scale, with values greater than 50 representing "Meets criteria", values 40–49 representing "Inconclusive", and values below 40 representing "Violates". We rescaled these values so that 75 and above received an A, 50–74 received a B, 40–49 received a C, and 40 and below received an F. We first rescaled all the station data and then we calculated the mean grade for each region from the most recent survey at all stations meeting the date range and assessment criteria.

Indicator: Turbidity

Indicator importance: The Verde River provides approximately 40% of the surface water used by the Phoenix Metropolitan Area. However, upstream erosion and the risk of catastrophic wildfires could one day make water from the Verde River difficult to treat, reducing its usability. Turbidity, a measure of water clarity, was assessed against standards for water treatment in downstream communities.

Data source: City of Phoenix via the Salt River Project (SRP)

Calculation method: Turbidity reflects the health of a river system for fish and aquatic benthic habitat. It can also indicate other water quality issues in cases where turbidity is elevated due to excessive algae growth supported by nutrient pollution. However, turbidity also indicates the suitability of water sources for domestic supply. In conversations with down-stream water users this was a primary concern, closely related to the cost of treating Verde River water for the Phoenix Metropolitan Area. Although it would have been ideal to measure turbidity throughout the watershed and use these measurements to grade each reporting region separately, sufficient data for this purpose did not exist at the time the Report Card was developed. Therefore, we graded turbidity in one location at the bottom of the watershed, where it enters municipal drinking water supplies in the Phoenix Metropolitan Area.

The City of Phoenix provided permission to use data from the Val Vista Water Treatment Plant (VVWTP) for the turbidity water quality indicator. Phoenix has been collecting data on turbidity events since 2007. The turbidity events can be heavily influenced by flows from the Verde River because, while water that reaches VVWTP comes from a mix of sources, these other sources (Central Arizona Project, Salt River, and groundwater) are generally less turbid than Verde water.

Elevated turbidity events, called "Undesirable Events" are ones where the average daily turbidity at the water treatment plant is greater than 500 NTU (Nephelometric Turbidity Units). This results in conditions where the water is "undesirable" but treatable. Since 2007, VVWTP has averaged less than 1 Undesirable Event per year (0.88). Since 2007 there have been no "Untreatable Events" (>8,000 NTU), however, there have been a few times when mitigation for short durations was required. Mitigation includes blending with Salt River, CAP, or groundwater and adjustment to treatment plant operations.

In discussion with City of Phoenix, acceptable turbidity levels were defined for water treatment:

- Below 500 NTU is "acceptable"
- 500 to 8,000 NTU is "undesirable"
- Above 8,000 NTU is "untreatable"

Based on the historic number of undesirable events since 2007, it was decided that the number of undesirable events would translate to a letter grade using the following system:

- If Undesirable Events = 0 or 1 then grade is A (if 0, then score = 100, if 1, then score = 90)
- If Undesirable Events = 2 or 3 then grade is B (score = 70)
- If Undesirable Events = 4 or 5 then grade is C (score = 50)
- If Undesirable Events = 6 or 7 then grade is D (score = 30)
- If Undesirable Events = 8 or 9 then grade is F (if 8, then score = 10), if 9 or greater, then score = 0)
- And for each Untreatable Event, grade is lowered by one letter (score = score - 20)

For future report cards, we propose to use data from the SRP turbidity sensor located at the Verde River Near Scottsdale USGS gage for this indicator. SRP's continuous measurement turbidity sensor has only been active since July 2016, but is a better measurement point because it best reflects the condition of the Verde River before it enters the SRP canal system. The water that arrives at treatment plants is really a blend of Salt River, CAP water, and groundwater in addition to Verde River water, so treatment plant data is less reflective of the Verde River. When the data source is changed, it may be necessary to adjust the thresholds.

Habitat

Habitat indicators measure habitat quality for plants and animals in the watershed found in three distinct types of habitat: uplands, riparian, and aquatic.

Upland

Indicator: Upland Condition Index

Indicator importance: Healthy rivers are supported by healthy land. The Upland Condition Index uses indicators from the U.S.D.A. Forest Service Watershed Condition Framework to assess the extent to which upland areas in a region are functioning as would be expected in the absence of human activities.

Data source: The United States Department of Agriculture Forest Service Watershed Condition Framework, which is available online:
https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml
https://www.fs.fed.us/biology/resources/pubs/watershed/maps/Watershed_Condition_Framework2011FS977.pdf
https://www.fs.fed.us/biology/resources/pubs/watershed/maps/watershed_classification_guide2011FS978.pdf

Calculation method: The Watershed Condition Framework (WCF) is a 12-Indicator model covering the physical and biological characteristics of aquatic and terrestrial habitats. The framework has been applied to HUC12 watersheds within USFS lands at a national extent. The data are provided in the form of a shapefile with attributes for each of the 12 indictors. Each indicator is ranked good, fair, or poor for each watershed. Of the 12 indicators, the first 5 (Water Quality, Water Quantity, Aquatic Habitat, Aquatic Biota, and Riparian/Wetland Vegetation) address Aquatic conditions. The remaining 7 indicators address the terrestrial physical conditions (Roads and trails, and Soils) and terrestrial biological conditions (Fire regime or Wildfire, Forest Cover, Rangeland Vegetation, Terrestrial Invasive Species, Forest Health). Weighting of these indicators is not even: Aquatic conditions are weighted 60% and Terrestrial conditions are weighted 40%. Further, within Terrestrial conditions, physical indicators are weighted 75% and biological are weighted 25%. For the purposes of this report card we maintained this weighting system.

Because the report card contains aquatic and riparian habitat indicators developed by local stakeholders, the report card only uses the Terrestrial, Physical, and Biological indicators from the WCF for the Upland Condition Indicator. The WCF shapefile was used to access the seven terrestrial indicators for analysis. The Good, Fair, and Poor ranking provided for each indicator was converted into a score and grade (Table 3). The seven indicators were then aggregated up to a watershed score for each HUC12 through the calculation of a weighted average using weights provided by the WCF technical documentation, resulting in physical indicators being weighted 3-times more heavily than biological indicators. Data was available for all HUC12s that overlapped with USFS lands. In areas where there is no naturally occurring forest habitat, the forest cover indictor was reported as "no data" in the WCF. We aggregated HUC12 scores up to each reporting region by calculating an average weighted by the area of each HUC12. Missing data (e.g., areas lacking natural forests or WCF classification) was not included in the area-weighted average.

WCF class	Report Card Score	Grade
Good	100	A

		B
Fair	50	C
		D
Poor	0	F

Table 3: Watershed Condition Framework score conversions.

Riparian

Indicator: Riparian Birds

Indicator importance: The Verde River Watershed is home to one of the rarest forests on earth, the Fremont Cottonwood-Goodding Willow Gallery Forest. Formed by the connection between the river and its desert surroundings, these forests, when healthy, support an incredible diversity of bird species. To measure riparian forest health, we compared the current number of bird species in a region to a list of species expected to nest in the riparian area of the region.

Data source: the Arizona Game and Fish Department (AZGFD) maintains a comprehensive database of species observations for the state. Matthew King (mking@azgfd.gov) is the system manager for the database. Through a data request for the report card, we retrieved lists of riparian bird species in the database for each reporting region.

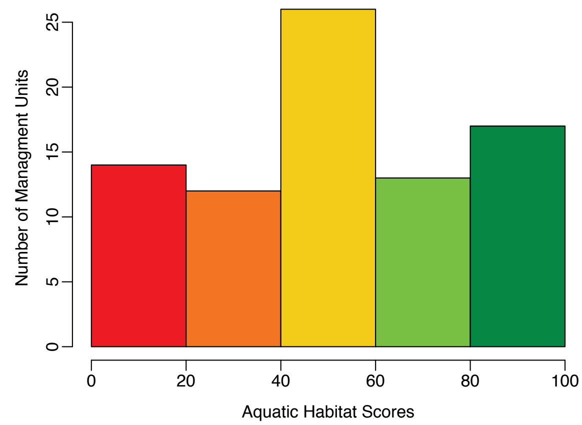
Calculation method: A total of 87 unique bird species were identified as breeding in the Riparian Zones of the Verde River Watershed. For each species, a time period was identified for the breeding season, which generally started between March and May and ended between July and August.

The indicator is based on the ratio of how many bird species were actually observed to be present in the past two years to how many bird species are expected be present in riparian zones during the breeding season. The list of expected observations was from the Arizona Game and Fish (AZGF) Element Occurrence database and the Arizona Breeding Bird Atlas (ABBA). These databases provided the baseline list of bird presence. The baseline was tabulated separately for each reporting region.

For riparian birds observed in the past two years (2017–2018), we used eBird observations, also tabulated by reporting region. There were between 1,353 and 42,201 eBird observations of birds in each region (Table 4). In general, this gave us confidence that there were sufficient observers looking for birds that if a bird was actually breeding in the region, there was a high probability it would be observed. However, region 2 and 6 might be exceptions to this assumption as there is good riparian habitat in these regions, but access is poor. The final calculation for the Riparian Bird indicator was made as the fraction of species that were observed by citizen scientists over the past two years.

Table 4: Bird observations in each region.

	# of eBird Observations
Region 1	22970
Region 2	1353
Region 3	11373
Region 4	42201
Region 5	22740
Region 6	2319
Region 7	12937



Aquatic

Indicator: Fish

Indicator importance: Fish diversity is tightly connected to the quality of aquatic habitats in any river or stream. To assess whether aquatic habitats are supporting desired fish communities, we compared the species present in an area to the species that the Arizona Game and Fish Department has identified as desirable or undesirable.

Data source: AZ Game and Fish Department provided data from their Verde Watershed Fisheries Management Plan, available at: http://arcgis.azgfdportal.com/verdewatershed/

Calculation method: AZGFD's Verde Watershed Fisheries Management Plan includes 82 management units within the watershed that were graded for aquatic habitat condition. Within the plan primary and secondary management emphases and objectives are described in unit descriptions. For each unit, AZGFD maintains a list of desirable and undesirable species. Species present that are not on either of these lists (i.e., are deemed neither desirable nor undesirable) are also included. Based on its geographic location, each management unit was associated with one of the report card regions. In two cases, a unit spanned two regions and was therefore associated with each.

The indicator grades were calculated as the difference between the fraction of desirable species present minus the fraction of all species that were undesirable:

$$\text{Aquatic Habitat Indicator Score} = ((D_p/D) - (U_p/(D_p + U_p + O_p))) * 100$$

Where, D_p is the number of desirable species present, D is the total number of desirable species managed for, U_p is the number of undesirable species present, and O_p is the number of other species present (neither desirable nor undesirable). The indicator score was then graded by quintile (see Figure 6) and aggregated by averaging up to the report card region. Application of this method resulted in a relatively even distribution of units across the full range of possible scores (Figure 6).

Figure 6: Quintiles of the Aquatic habitat scores.

Communities

Community indicators are designed to measure quality of life for people in the watershed. These indicators cover a broad selection of the many possible interactions between people, the economy, and the environment.

Vitality

Indicator: Affordable Housing

Indicator importance: A lack of affordable housing is one of the most fundamental challenges communities in the Verde River Watershed face. Using data from the U.S. Census Bureau, the proportion of households spending more than 30% of their income on housing in each region was compared to the national average.

Data source: U.S. Census Bureau; American Community Survey, ACS 2017 (5-Year Estimates), Accessed Online Nov 2019

Calculation method: The data used to indicate affordable housing was derived from *B25106: Tenure by Housing Costs as a Percentage of Household income in the Past 12 Months*. These data were developed from *Selected Monthly Owner Costs as a Percentage of Household Income* for owner-occupied and *Gross Rent as a Percentage of Household Income* for renter-occupied units. In either case (owner- or renter-occupied), ACS variable B25106 provides the number of households allocating total income to housing at three levels: (1) Less than 20%, (2) 20 to 29%, and (3) 30% or more. For this indicator of affordable housing, we calculated the proportion of households allocating less than 30% to housing.

The "30% of income spent on housing" threshold is a widely recognized indicator of housing costs. For example, the Federal Reserve characterizes a household as "housing cost burdened" if it spends more than 30 percent of its income on housing costs. In 2017, on average, 32% of all households were housing burdened nationally, meaning 68% spent less than 30% of income on housing.

In recognition of these national statistics, the affordable housing indicator was linearly scaled between 50% and 100%. Regions with less than 50% of households spending less than 30% of income on housing, would receive a score of 0 (F). Conversely, regions with 100% of households spending less than 30% of income on housing received a score of 100 (A). Using this scoring system, a region at the national average of 68% of households spending less than 30% of income on housing would receive a D.

Indicator: Unemployment

Indicator importance: For communities in the watershed to thrive its citizens must have access to good jobs. This indicator measures the proportion of the community that is employed using U.S. Census Bureau data.

Data source: U.S. Census Bureau; American Community Survey, ACS 2017 (5-Year Estimates), Accessed Online Nov 2019

Calculation method: The data used to indicate unemployment was derived from *B23025: Employment Status for the Population 16 Years and Over.* All civilians 16 years old and over are classified as unemployed if they (1) were neither "at work" nor "with a job but not at work" during the reference week, (2) were actively looking for work during the last 4 weeks, and (3) were available to start a job. Also included as unemployed are civilians who did not work at all during the reference week, were waiting to be called back to a job from which they had been laid off, and those who were available for work except for temporary illness. This census variable provides employment data for civilians, therefore is not influenced by the proportion of the population in the armed forces. As there will always be some people in any population who are between jobs, the minimum unemployment rate is assumed to never go below 3%. At the other extreme, a 15% unemployment rate indicates serious problems with the economy. Therefore, for this indicator the unemployment rate was linearly scaled between 3 and 15% and corresponded these rates with indicator scores of 100% (A) and 0% (F).

Indicator: Education

Indicator importance: The children of the Verde River Watershed are its future. To measure whether children have adequate educational opportunities, we examined the high school graduation rate in each region.

Data source: Arizona Education Progress Meters, Center for the Future of Arizona

Calculation method: The data provided were the high school graduation rates for nine cities in the watershed. Each city's graduation rate was scored based on the threshold recommendation provided by stakeholders. The thresholds were a graduation rate of 90% equaling an A grade (80% score) and a graduation rate of 70% equaling an F grade (20% score). The cities were organized by reporting region and the graduation rate scores were averaged within each region. All regions had scores except for region 2, because region 2 has no high schools within its borders.

Citation: Arizona Education Progress Meter, Center for the Future of Arizona. More information at https://www.arizonafuture.org/az-progress-meters/overview/

Indicator: Healthcare

Indicator importance: Healthy communities have healthy people. To assess access to healthcare we calculated the proportion of people in each region with health insurance using data from the U.S. Census Bureau.

Data source: U.S. Census Bureau; American Community Survey, ACS 2017 (5-Year Estimates), Accessed Online Nov 2019

Calculation method: Healthcare is reported as the proportion of people within a region with health insurance. The data used to indicate healthcare was derived from *B27001: Health Insurance Coverage Status by Sex by Age.* From these data we summed up all individuals with and without health insurance across all sex and age categories. We then calculated the indicator as the fraction of all people with health insurance. The stated goal for this indicator is to have all people covered by health insurance. Currently the Future of Arizona calculates that 82% of people in Arizona have health insurance. The health insurance rate was linearly scaled between 60% and 100% so that the state average would fall roughly at the middle of the distribution and a region matching the statewide average insurance rate would receive a C.

Engagement

Indicator: Digital Engagement

Indicator importance: For many people the digital world is an important way to learn about and experience the river. To capture this type of engagement we compared the number of times water related topics in an area were searched for on Google using data from Google Trends.

Data source: Google Trends (https://trends.google.com)

Calculation method: The digital engagement indicator is based on results from Google Trends queries. Search terms were identified from each region based on (mostly aquatic) place names (Table 5). In some cases, the search term was the prominent feature of the region (e.g., Oak Creek), but in others the search term was a large lake, park, or other feature (e.g., Bartlett Lake). Search terms were queried in groups of 5 (the maximum allowed by Google), with the search term *Verde River* included in all groups of 5. Google scales each group of 5 to the range of 0 to 100 – including *Verde River* in each group of 5 provided the opportunity to normalize results across searches, thus facilitating comparison across reporting regions. The search for each term resulted in weekly data for the past 5 years (260 values).

Table 5: Scores for different search terms.

Search Term	Region	Score
Verde River	0	73
Goldwater Lake	1	38
Lynx Lake	1	58
Watson Lake	1	62
Granite Creek	1	36
Fain Lake	1	27
Sycamore Canyon	2	40
Perkinsville	2	32
Bear Sighting	2	24
Dead Horse State Park	3	44
Dead Horse Ranch State Park	3	36
Tuzigoot National Monument	3	31
Tapco	3	31
Tavasci	3	24
Oak Creek	4	100
Slide Rock State Park	4	48
Red Rock State Park	4	47
Wet Beaver Creek	5	37
West Clear Creek	5	35
Montezuma Well	5	35
Montezuma Castle	5	76
Fossil Creek	6	100
Sheeps Bridge	6	31
Tonto Natural Bridge State Park	6	29
Bartlett Lake	7	83
Horseshoe Lake	7	42
Phon D Sutton	7	30
Needle Rock	7	31

A gain and offset were calculated between the first search for *Verde River* and each subsequent search for *Verde River* and subsequently used to rescale each group of searches to the scale of the first group of searches. For example, the gain (m) and offset (b) were calculated by fitting $y = m*x+b$, where y is the values returned for *Verde River* in the first group of five search terms and x is the values returned for *Verde River* in the second group of five search terms. The gain and offset were then applied by replacing x with the values returned for each of the remaining four search terms in the second group of five, and then solving for y. The calculated values were then retained as the rescaled results for each search term in the second group of five. When this process was completed for each group of five search terms (each scaled to the results of the *Verde River* search in the first group of five), we were left with search results that could be compared across all Google Trends searches.

The last two years of data (i.e., the reporting period) were scored using the top three performing search terms for each region. As is apparent from Table 5, there were a variable number of search terms across regions, but there was always a minimum of three. The mean score for the top three search terms for each region was calculated.

After the three top search terms were identified for each region, a z-score was calculated and scaled between -2.5 and 2.5 (corresponding to report card scores 0 and 100, respectively). Z-scores require a mean and standard deviation to use as the basis of the scaling. Since there are no expected values for these Google Trends scores, we scaled against a random sample from the full list of search terms. To do so, we iteratively selected three random search terms from the table, calculated their mean, and repeated 1000 times. The mean and standard deviation of these 1000 random samples were the basis for calculating z-scores for each region.

Overall, the approach used for this indicator compares each region against the mean and standard deviation of all the possible search terms across the Verde river watershed. This essentially pits each region against the other regions and does not try to establish a critical threshold for the Google Trends results. This is necessary because the Google Trends results are unitless and the values depend on the range of values for the search terms used. However, differences between the regions (search terms) are preserved. Because the variance among search terms (not regions) is used to score the regions, the result will always highlight regions with several highly performing (or low performing) search terms. However, if every region had one high performing search term and one low performing search term, every region would get approximately a 'C'.

A drawback to this approach is that there could be another (unidentified) search term for some of these regions that would perform better (return a higher value in Google Trends). We attempted to limit this concern by identifying many search terms for each region. To further investigate the data, we looked at trends in data returned from each region and search term. It was not envisaged that these trends would be reported in the report card, but it was useful to see that certain management decisions (such as enacting a permit limit at Fossil Creek) were represented in the google trend results.

Indicator: Civic Engagement

Indicator importance: For the river to persist over the long-term the communities who depend on it must be invested in its health. To assess the extent to which local governments are engaging in conversations about water-related issues, we examined the number of times water-related topics appeared in regular meeting minutes of local governments.

Data source: Meeting minutes collected from municipal and county government websites

Calculation method: The goal of this indicator was to measure the engagement of local governments throughout the watershed on conservation topics. Similar to the digital engagement indicator, we used the occurrence of place names with conservation meaning to indicate engagement. However, in this case, instead of using digital media as the data source, we used meeting minutes collected from the websites of municipal and county governments in the watershed. We also attempted to include Native American Tribes and Nations, but were unable to find a publicly available copy of meeting minutes. We searched each document (meeting minutes) for occurrences of all search terms. We recorded the number of documents with each search term and also the number of occurrences of each word across all documents (thus counting multiple occurrences of the same term in a single document.) However, we ultimately only graded the presence of each search term, not the abundance, therefore if a search term occurred one time then the government got credit for that mention and no more credit for discussing the term many times in the same meeting.

The indicator aggregated data from all meetings in 2018 and 2019. Since 2019 was not complete when the report card data analysis period ended, we missed a few meetings at the end of the year. However, for the most part, 24 documents were reviewed in each year (civic groups in the Verde watershed met on average very 2 weeks.) Across these documents, we searched for the 28 search terms listed above (Table 5). We also added the term "watershed" to the search term list. We then identified the three highest performing search terms for each civic group and calculated the mean mention rate across these three terms. We found that the distribution of the search term mention rate was skewed towards many low values and few high values. Therefore, we calculated the log(search term mention rate) and used this as the score going forward. For each government, we used this approach to calculate a score for 2018 and 2019, and then calculated the mean across both years.

After all (search term mention rate) scores for governments had been calculated, we calculated a z-score for each government. To calculate the mean and standard deviation used in the z-score, we first removed the highest and lowest performing governments. We used these statistics to calculate a z-score for each civic group. We then scaled the z-score range from -2.5 to 2.5 to 0 to 100 to match the report card scoring method.

After scoring each civic group, we aggregated group scores up to the region level by calculating a population-weighted mean. Using the population layer described earlier, we calculated the proportion of each reporting region population that lived within the boundaries of each jurisdictional boundary. These proportions were used in the population weighted mean for each reporting region. When aggregating up to the entire Verde watershed, we also weighted by the population of each region. Note that by using this method, small towns that are surrounded by county lands influence the overall score in proportion to their population, not their area.

Recreation

Indicator: Recreation Access

Indicator importance: In addition to the solitude that can come with remote locations, it is important that people in the watershed have the opportunity to experience nature near their homes. To assess recreational access, we measured the proportion of people with an outdoor recreational opportunity within 3 miles of their home.

Data source: U.S.D.A. Forest Service Recreation Opportunities Map (https://data.fs.usda.gov/geodata/edw/datasets.php?dsetParent=Recreation), Arizona State Parks and Trails Statewide Trailhead Map (https://www.arcgis.com/home/item.html?id=ce4e69a454ad492692e89301414757ec), Arizona State Parks and Trails Park Locations Map (https://www.arcgis.com/home/item.html?id=2bdcb0d8c38d4c639b07920944419697), manual identification via Google Earth

Calculation method: The indicator began by combining the U.S.D.A. Forest Service's Recreation Opportunities, Arizona State Parks and Trails Statewide Trailhead, and Arizona State Parks and Trails Park Locations layers (see above for links to data sources) into a single shapefile and clipping this shapefile to the Watershed's boundaries in QGIS (v. 3.8). Additional parks that offered outdoor recreation not included in these datasets, primarily those operated by municipalities, were then manually identified by the Report Card team in Google Earth Pro and added to the aforementioned shapefile. The resulting shapefile was then manually cleaned for duplicates.

To score this indicator, the resulting point file of recreation opportunities was compared with the population map for each region. We calculated the number of people in the region within 3 miles of each recreation opportunity location, and also the total number of people in the region. For each region, we used these two values to calculate the fraction of the region population that is within 3 miles of a recreation opportunity.

Standards for this indicator are few, however American Trails has set a goal of providing a trail network within 3 miles of 90% of Americans by 2020. We adopted this goal but extended it to any recreational opportunity (not just trails) and graded such that if a region achieved the goal the region would get an 'A'. Therefore, we scored linearly between 50% of the population within 3 miles of a recreation opportunity (score = 0) and 100% (score = 100), which placed the 90% goal at a score of 80 (i.e., the transition from B to A).

Indicator: Visitor Satisfaction

Indicator importance: The Verde River Watershed is known for its excellent recreational opportunities. Using the U.S.D.A. Forest Service's National Visitor Use Monitoring Survey, we measured the proportion of people who were satisfied with their experience on Forest Service lands.

Data source: USFS National Visitor Use Monitoring survey

Calculation method: Overall visitor satisfaction in the Verde River Watershed was evaluated using the results of the National Visitor Use Monitoring surveys and was graded on a pass/fail scheme. Watershed visitors indicated the overall satisfaction of their visit to the watershed out of five options: (1) Very Satisfied, (2) Somewhat Satisfied, (3) Somewhat Dissatisfied, (4) Very Dissatisfied, or (5) Neither. Results that were "Very Satisfied" or "Somewhat Satisfied" passed (scoring 100%), while those that were "Somewhat Dissatisfied", "Very Dissatisfied", or

"Neither" failed (scoring 0%). The 0–100% scores for each region were averaged together to produce region scores.

Indicator: Recreation Planning

Indicator importance: Sustainable recreation requires careful planning. For this indicator we assessed the quality of recreation plans for land management agencies in the watershed that allow public recreation on their lands, Arizona State Trust Lands, Coconino National Forest, Kaibab National Forest, Prescott National Forest, the U.S. National Park Service, and Tonto National Forests.

Data source: U.S.D.A. Forest Service Website, National Parks Service, Email correspondence with Arizona State Lands Department

Calculation method: To score recreation planning we examined the organization wide recreation plans for six of the largest land managers that allow recreation on their lands in the watershed, Tonto National Forest, Prescott National Forest, Coconino National Forest, Kaibab National Forest, and Arizona State Lands Department, and the U.S. National Park Service. Though Arizona State Lands Department is dissimilar to these federal agencies in a variety of ways, it was included in this analysis because public recreation is allowed on much of their lands with the purchase of a permit. Further, we recognize that a large amount of recreation planning occurs at smaller spatial scales. The purpose of this metric was not to assess individual local plans, but rather to assess the context in which these plans are made. Plans were graded along the following parameters:

a. **Existence and Ease of Access.** Forest Plans, which include extensive recreation components were downloaded an analyzed from the website of each of the National Forests identified above. Plans for Tuzigoot National Monument, Montezuma Well, and Montezuma Castle were downloaded from the National Parks Service Website. Email conversations with the Arizona State Lands Department showed that the department does not have a recreation plan. Jurisdictions without a plan received a score of 0. Jurisdictions with a plan received 20 points.
a. **Date Since Last Update.** Given the rapid population and economic growth in the watershed, recreation plans must be regularly updated to be effective. Conversations with stakeholders identified that ten years was a reasonable and effective timetable for updating recreation plans, matching the expected update cycle for U.S.D.A. Forest Service plans. To reflect this, plans updated this year (2019) were given 20 points. This was reduced by two points each year the plan was in place until it was 10 or more years old, at which point the plan would get 0 additional points.
b. **Needs Assessment.** Good recreation plans should describe the recreation needs of the jurisdiction within the context of past planning and anticipated future

conditions. Plans that explicitly addressed the existing planning context were given 20 points.

c. **Public Participation.** Public participation in plan generation is a critical component of building sustainable recreation plans that are matched to community needs. Plans that involved the public in their generation were given 20 points.

d. **Desired Conditions.** The types and intensity of recreation that a given location can support often vary throughout a jurisdiction. Plans that explicitly recognized this fact and established site-specific desired recreation conditions were give 20 points.

Final scores were tabulated by converting points, ranging from 0-100, to percent, ranging from 0-100.

Synthesis

To combine the indicators together, several steps were taken. Indicators were aggregated from the region level to the watershed level through the calculation of a weighted mean. The weights were either the region area or the region population. Area weighting was used for all indicators except for the Community indicators, where population weighting was used. The exception was recreation planning, where area weighting was used because recreation plans pertain to a specific landscape area rather than its population. This resulted in an overall score for each indicator.

Each indicator was averaged to the category level and then each category was averaged to the value level. The three value scores (Water, Habitat, and Communities) were equally weighted in an average overall Verde Watershed Health Score.

Each region score was calculated by following similar steps. The indicator score in a specific region was averaged to the category level and then each category was averaged to the value level. No weighting occurred for the region scores since each region has an individual score. The final overall scores can be seen in Figure 7.

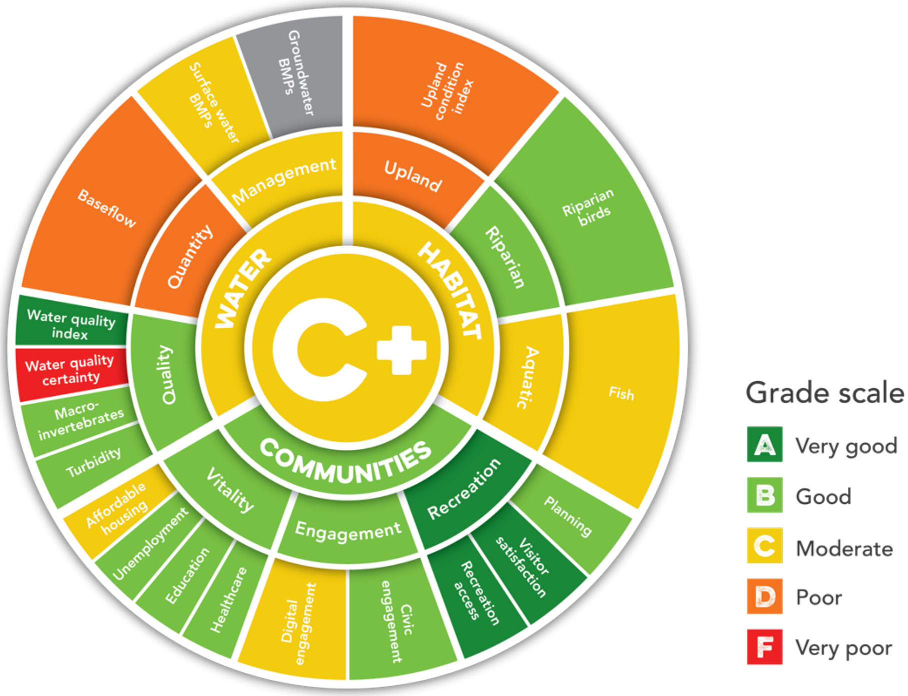


Figure 7: Overall scores for the indicators, categories, and values.

Communication

Watershed report cards, much like school report cards, provide performance–driven numeric grades or letters that represent the relative ecological and social health of a geographic region or component of the ecosystem. They are an important tool for integrating diverse data types into simple scores that can be communicated to decision makers and the general public. In other words, large and often complex amounts of information can be made understandable to a broad audience.

Watershed report cards enhance research, monitoring, and management in several ways. For the research community, they can lead to new insights through integration schemes that reveal patterns not immediately apparent, help to design a conceptual framework to integrate scientific understanding and environmental values, and help to develop scaling approaches that allow for comparison in time. Within monitoring realms, report cards justify continued monitoring by providing timely and relevant feedback to managers and can have the added benefit of accelerating data analyses. For management, they provide accountability by measuring the success of restoration efforts and identifying impaired regions or issues of ecological concern. This catalyzes improvements in ecosystem and social health through the development of peer pressure among local communities. Report cards also can guide restoration efforts by creating a targeting scheme for resource allocation.

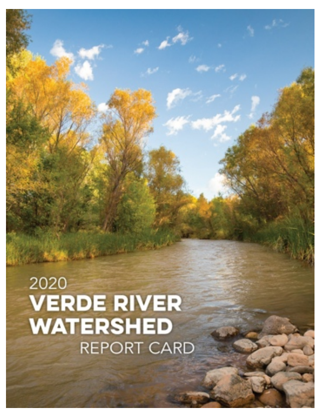
Watershed health assessments have become more common in recent years, and report cards are being produced by a variety of groups from small, community–based organizations to large partnerships. Although methods, presentation, and content of report cards vary, the underlying premise is the same: to build community awareness and raise the profile of health impairment issues and restoration efforts.

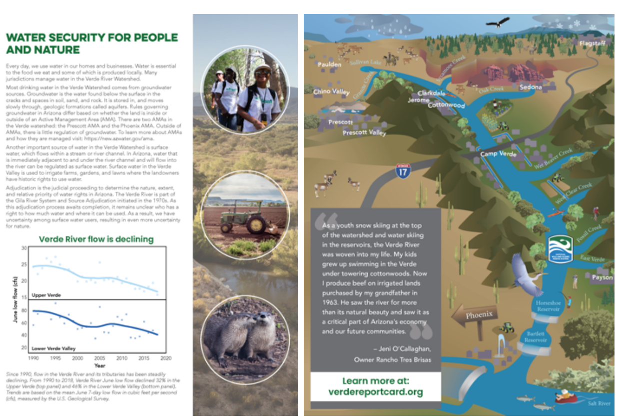
Some common elements of report cards include:

1. A map of the watershed or region

2. A conceptual diagram
3. Indicator scores
4. A summary of the key features (e.g., ecosystem types, recreation activities)
5. A “What You Can Do” section

For the Verde River Watershed Report Card numerous meetings were conducted to plan the content, layout, and design of the documents. Many iterations of the report card occurred as the document evolved into its final state. The report card is an 8-page gatefold style document. The report card provides background information on the region, impacts to the ecosystems, information about water security, details about the wild and scenic reach of the river, data on actions that partnerships in the watershed have been taking to restore and conserve the river, and information about what the public can do to make a difference, in addition to the methods, scores, and grades. This report card provides a synthesis of monitoring data being collected in the Verde River Watershed in a visually appealing and engaging manner. The report card is supported by a full website which gives additional details of the scores for each region and indicator. View this information at: www.verdereportcard.org.





THE VERDE RIVER WATERSHED IS IN MODERATE CONDITION

Overall, the Verde River watershed earned a score of 57%, a C+. Of the three categories, Water and Habitat had moderate scores, 49% and 54% respectively, and Communities had a good score, 69%. Baseflow scored poorly, (38%) reflecting nearly 30 years of steadily declining baseflows. The lowest scoring indicator was water quality certainty, which was very poor (19%), and measures how certain we are that the water quality scores are accurate. This is due to the need for increased monitoring efforts throughout the watershed. While some reaches are studied extensively, others are studied very little or not at all. The highest scoring indicators were in the Communities category; both recreation access and visitor satisfaction had very good scores, 87% and 96%, respectively. There are many recreational opportunities available across the watershed and visitors are happy with their experiences on and around the river. The habitat category had mixed results. Upland habitat had a poor score (36%) and riparian birds had a good score (77%). Habitat scores are affected by many factors, including the susceptibility of soil to erosion, risk of catastrophic wildfire, and the quality of vegetation near streams and rivers for bird habitat. More details are available at verdereportcard.org.

How ecosystem health was evaluated

Watershed report cards are powerful tools used around the world to describe ecosystem status, increase public awareness, and inform and influence decision makers to act to improve the health of a watershed. This is the first Verde River Watershed Report Card and it reflects the collective effort of dozens of stakeholders that manage land, water, and wildlife in the Verde watershed. The five-step report card process (below) was highly participatory, involving the engagement of over 16 entities over an 18-month process of workshops, data compilation, and stakeholder interviews. Three categories of indicators were selected to evaluate the overall health of the Verde watershed: Water, Habitat, and Communities. Status of indicators within these categories was evaluated by comparing data to scientifically-derived thresholds or goals. Each region score is area-weighted or population-weighted to attain the overall Verde Watershed score.

Grade scale

- A Very good (100–80%)
- B Good (79–60%)
- C Moderate (59–40%)
- D Poor (39–20%)
- F Very poor (19–0%)
- U Unscored

Big and Little Chino C+

The Big and Little Chino had a moderate score, 55%, a C+. The highest-scoring indicators were visitor satisfaction and healthcare. The lowest-scoring indicators were upland habitat, aquatic habitat, and water quality certainty. This region had the lowest score for the water quality index indicator in the watershed. The Big and Little Chino are the names of both the aquifers and grasslands in this region. The grasslands provide habitat for pronghorn, burrowing owls, and prairie dogs, while supporting a vibrant livestock grazing industry. The aquifers serve the towns of Prescott, Prescott Valley, and Chino Valley and contribute to most of the flow in the Upper Verde River.

Upper Verde Valley C+

The Upper Verde Valley had a moderate score, 55%, a C+. Indicators with low scores were upland habitat, baseflow, and aquatic habitat. This region had the lowest baseflow score in the watershed. Higher scoring indicators were recreation access, recreation planning, and visitor satisfaction. This region had the highest recreation access score in the watershed. In this region, the river enters the Verde Valley, where water is used for recreation (kayakers), agriculture, and landscaping. Clarkdale and Cottonwood have recreation opportunities along the banks of the river with Deadhorse Ranch State Park and Tuzigoot National Monument.

Lower Verde B-

The Lower Verde had a good score, 62%, a B-. This region had the highest scores for water quality certainty, education, and healthcare in the watershed. Conversely, it had the lowest scores in the watershed for upland habitat and recreation planning. This region includes the Horseshoe and Bartlett dams that ensure Arizona has a robust and resilient water supply. Abundant and diverse wildlife flourish between the reservoirs and the Fort McDowell Yavapai Nation, where the Verde meets the Salt River just northeast of Phoenix.

C Upper Verde

The Upper Verde had the lowest score of any region, with 51%, a C. This was due to low scores in water quality certainty, recreation access, and upland habitat. This region had the lowest score for recreation access in the entire watershed. Some of the higher scoring indicators in this region were recreation planning, visitor satisfaction, and unemployment. The region includes the source of the Upper Verde River near the confluence with Granite Creek and flows to Sycamore Creek. This stretch is characterized by canyon walls and abundant wildlife. While there are limited access points, many visit this section of the watershed via the Verde Canyon Railroad.

B Oak Creek

Oak Creek was the highest scoring region in the Verde, with 65%, a B. This region had perfect scores (100%) in recreation planning and digital engagement. Recreation access and visitor satisfaction also had very good scores. This region had the highest scores for baseflow and macroinvertebrates (small aquatic animals) in the watershed. Lower-scoring indicators were water quality certainty and affordable housing. Most Arizonans know Oak Creek for its stunning red rocks and crystal clear waters, but it also supports agriculture and aquaculture. Arizona Game and Fish Department's Page Springs Fish Hatchery produces more than 70,000 trout each year.

B- Lower Verde Valley

The Lower Verde Valley had a good score, 62%, a B-. High-scoring indicators were the water quality index, recreation planning, recreation access, visitor satisfaction, and surface water BMPs (best management practices). This region had the highest civic engagement score in the watershed. Lower scores in the region were water quality stability and affordable housing. The Lower Verde Valley includes Beaver Creek and West Clear Creek. It is a diverse mix of public and private lands with the town of Camp Verde at its center. Recreation opportunities include exploring Montezuma Castle National Monument, picnicking in Camp Verde's Rezzonico Park, and kayak launches from Forest Service access points.

C Wild and Scenic

The Wild and Scenic region had a moderate score, 54%, a C. The lower scores were in water quality certainty, baseflow, civic engagement, and education. Higher-scoring indicators were water quality index, riparian habitat, and digital engagement. This region includes the river segments designated as part of the National Wild & Scenic River System and the community of Payson. In 1984, 40.5 miles of the river between Camp Verde and Horseshoe Reservoir were designated and another 16.8 miles of Fossil Creek were added in 2009.

Learn more at: verdereportcard.org

THE VERDE RIVER: A RIBBON OF GREEN IN AN ARID LANDSCAPE

The Verde River is 190 miles of flowing water—one of Arizona's last living rivers. The watershed is incredibly diverse—at 6,600 square miles it encompasses wide-open grasslands, ponderosa pine forests, and desert landscapes. The ribbon of green created by the river is a small part of the land area but a large part of the biodiversity. The USDA Forest Service is a critical land and water manager across four National Forests in the watershed that cover 70% of its area.

The Verde River springs to life in a narrow canyon, fed by groundwater that emerges from aquifers underneath the Big and Little Chino Valleys—some of the largest and highest-quality grasslands in Arizona. The rain that falls here recharges the underlying aquifers. The Big Chino aquifer supplies about 80% of the flow to the first 24 miles of the Verde River.

The river changes as it flows south into the Verde Valley. This 52-mile stretch is the most accessible area along the river and was originally settled for agriculture and mining. The Yavapai and Apache peoples have lived here since time immemorial. Seven large ditches divert water onto agricultural fields and yards. The river attracts people for boating and recreation, with public access in the Arizona State Parks' Verde River Greenway, municipal parks, and Forest Service access points. Oak Creek, the largest tributary to the river, cuts through the iconic red rocks of Sedona.

As the river continues south, it is bounded by canyon walls and limited access has preserved much of its natural character. Over 57 miles of river in the watershed are designated under the National Wild & Scenic Rivers Act, a federal recognition for free-flowing rivers with unique and outstanding values. As the Verde River approaches the confluence with the Salt River, it is impounded by Horseshoe and Bartlett dams. These reservoirs provide a crucial water supply to the Phoenix metropolitan area.

The Verde River is threatened by unrestricted groundwater pumping, surface water diversion, degraded habitats, and a changing climate. By working together, we can ensure that the river keeps flowing and our communities continue to flourish.

HEALTHY RIVERS, HEALTHY COMMUNITIES

Our vision of flowing waters ways, healthy riverside habitat, and successful human communities requires collaboration. Partnerships such as Verde Front Leadership Council, Verde Watershed Restoration Coalition, and the Verde Flow and Habitat Restoration Regional Conservation Partnership Program have brought together agencies, landowners, the agriculture sector, nonprofits, and other stakeholders. The results are significant:

- Removed invasive plants from more than 9,000 acres of riverside lands.
- Improved irrigation systems to reduce water demand by more than 40,000 acre feet annually.
- Introduced new crops and changed agricultural markets that added jobs in the economy, kept farms in production, and reduced consumptive use of water by more than 200 acre feet annually.
- Protected critical agricultural lands and riverside habitat on more than 3,300 acres of land through conservation easements.
- Developed state parks and conservation areas stretching from the Verde's headwaters, through the Wild and Scenic section, to its confluence with the Salt River.

Yet we have more to do. The Verde Watershed Report Card serves as a framework for measuring continued progress toward our vision by regularly evaluating the watershed with commonly identified metrics and driving actions to improve watershed health.

Learn more at: verdereportcard.org

You can practice a river-friendly lifestyle!

Reduce your water use to protect the river, lower costs, and use less energy.

Be a part of your community, stay informed, attend meetings, and make your voice heard.

Volunteer and donate with one of the many river-focused organizations.

I ♥ the Verde River

Acknowledgments

This report card is a timely, transparent assessment of Verde watershed health as of December 2019. This document was produced by the Nature Conservancy, Friends of the Verde River, and the University of Maryland Center for Environmental Science. The data and methods underpinning this report card are detailed in the methods document and at verdereportcard.org. Funding support for this project was provided by the Nina Mason Pulliam Charitable Trust and the USDA Forest Service.

All photos and graphics: The Nature Conservancy, Friends of the Verde River, and the Integration and Application Network.

The Nature Conservancy — nature.org
fs.usda.gov
Friends of the Verde River — verderiver.org
Nina Mason Pulliam Charitable Trust — ninapulliamtrust.org
umces.edu

Appendix

Table A: Bird species included in the riparian habitat indicator. There are four duplicates, which are included to represent alterative naming conventions for the same species.

NAME	COMMON_NAME
Accipiter cooperii	Cooper's Hawk
Agelaius phoeniceus	Red-winged Blackbird
Aix sponsa	Wood Duck
Anas platyrhynchos	Mallard
Anas platyrhynchos diazi	Mexican Duck
Anas diazi	Mexican Duck
Archilochus alexandri	Black-chinned Hummingbird
Ardea herodias	Great Blue Heron
Auriparus flaviceps	Verdin
Baeolophus ridgwayi	Juniper Titmouse
Baeolophus wollweberi	Bridled Titmouse
Bubo virginianus	Great Horned Owl
Buteo albonotatus	Zone-tailed Hawk
Buteo jamaicensis	Red-tailed Hawk
Buteogallus anthracinus	Common Black Hawk
Butorides virescens	Green Heron
Callipepla gambelii	Gambel's Quail
Calypte anna	Anna's Hummingbird
Cardinalis cardinalis	Northern Cardinal
Cathartes aura	Turkey Vulture
Catherpes mexicanus	Canyon Wren
Coccyzus americanus	Yellow-billed Cuckoo (Western DPS)
Colaptes auratus	Northern Flicker
Columbina passerina	Common Ground-Dove
Contopus sordidulus	Western Wood-Pewee
Corvus corax	Common Raven
Cynanthus latirostris	Broad-billed Hummingbird
Dryobates scalaris	Ladder-backed Woodpecker
Empidonax traillii	Willow Flycatcher
Empidonax traillii extimus	Southwestern Willow Flycatcher
Falco sparverius	American Kestrel
Geococcyx californianus	Greater Roadrunner
Geothlypis trichas	Common Yellowthroat
Haemorhous mexicanus	House Finch
Haliaeetus leucocephalus	Bald Eagle

Haliaeetus leucocephalus pop. 3	Bald Eagle - Sonoran Desert Population
Icteria virens	Yellow-breasted Chat
Icterus bullockii	Bullock's Oriole
Icterus cucullatus	Hooded Oriole
Ictinia mississippiensis	Mississippi Kite
Lanius ludovicianus	Loggerhead Shrike
Megaceryle alcyon	Belted Kingfisher
Megascops kennicottii	Western Screech-owl
Melanerpes formicivorus	Acorn Woodpecker
Melanerpes uropygialis	Gila Woodpecker
Meleagris gallopavo	Wild Turkey
Melospiza melodia	Song Sparrow
Melozone aberti	Abert's Towhee
Melozone fusca	Canyon Towhee
Mergus merganser	Common Merganser
Micrathene whitneyi	Elf Owl
Mimus polyglottos	Northern Mockingbird
Molothrus aeneus	Bronzed Cowbird
Molothrus ater	Brown-headed Cowbird
Myiarchus cinerascens	Ash-throated Flycatcher
Myiarchus tyrannulus	Brown-crested Flycatcher
Nycticorax nycticorax	Black-crowned Night-heron
Oreothlypis luciae	Lucy's Warbler
Parabuteo unicinctus	Harris's Hawk
Passer domesticus	House Sparrow
Passerina amoena	Lazuli Bunting
Passerina caerulea	Blue Grosbeak
Passerina cyanea	Indigo Bunting
Petrochelidon pyrrhonota	Cliff Swallow
Phainopepla nitens	Phainopepla
Pipilo maculatus	Spotted Towhee
Piranga rubra	Summer Tanager
Polioptila caerulea	Blue-gray Gnatcatcher
Polioptila melanura	Black-tailed Gnatcatcher
Psaltriparus minimus	Bushtit
Pyrocephalus rubinus	Vermilion Flycatcher
Quiscalus mexicanus	Great-tailed Grackle
Sayornis nigricans	Black Phoebe
Sayornis saya	Say's Phoebe
Setophaga petechia	Yellow Warbler
Sitta carolinensis	White-breasted Nuthatch

Spinus psaltria	Lesser Goldfinch
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Streptopelia decaocto	Eurasian Collared-Dove
Sturnus vulgaris	European Starling
Tachycineta thalassina	Violet-green Swallow
Thryomanes bewickii	Bewick's Wren
Toxostoma crissale	Crissal Thrasher
Tyrannus verticalis	Western Kingbird
Tyrannus vociferans	Cassin's Kingbird
Tyto alba	Barn Owl
Vireo bellii	Bell's Vireo
Vireo bellii arizonae	Arizona Bell's Vireo
Vireo huttoni	Hutton's Vireo
Zenaida asiatica	White-winged Dove
Zenaida macroura	Mourning Dove

Table B: Reporting regions include multiple HUC12 watersheds.

HUC12	TOHUC	AREA(ac)	AREA(SqKm)	NAME	REGION
150602030201	150602030205	27151.43	109.88	Ellison Creek	6
150602010303	150602010505	29732.49	120.32	Ash Fork Draw-Jumbo Tank	1
150602020610	150602020613	36150.92	146.3	Red Tank Draw	5
150602010704	150602010708	15225.56	61.62	Strickland Wash	1
150602030508	150602030509	10776.28	43.61	Alder Creek	7
150602020108	150602020401	27934.11	113.05	Muldoon Canyon-Verde River	1
150602020312	150602020314	18346.67	74.25	Middle Sycamore Creek	2
150602020603	150602020609	21676.25	87.72	Double Cabin Park-Jacks Canyon	5
150602030207	150602030210	18578.54	75.18	Middle East Verde River	6
150602030105	150602030107	30898.94	125.04	Lower Willow Valley	5
150602010406	150602010407	19740.36	79.89	Flagstone Tank-Partridge Creek	1
150602010710	150602010809	30396.96	123.01	Lower Williamson Valley Wash	1
150602020505	150602020508	17911.98	72.49	Upper Oak Creek	4
150602010201	150602010205	16523.09	66.87	Deer Tank	1
150602020303	150602020308	14944.03	60.48	Telephone Tank	2
150602020102	150602020107	28696.03	116.13	Upper Granite Creek	1
150602020511	150602020706	28822.89	116.64	Lower Oak Creek	4
150602030305	150602030307	25859.01	104.65	Upper Fossil Creek	6
150602020309	150602020312	14925.1	60.4	Upper Sycamore Creek	2
150602010104	150602010109	32981.91	133.47	Antelope Tank-Aubrey Valley	1
150602020701	150602020702	10531.83	42.62	Bitter Creek	3
150602030602	150602030603	9858.63	39.9	Mud Springs-Rock Creek	7

150602020206	150602020207	16265.87	65.83	Rattlesnake Wash	2
150602030409	150602030503	11519.17	46.62	Dry Wash-Verde River	6
150602030403	150602030409	16280.03	65.88	Red Creek	6
150602030703	150602030704	21967.38	88.9	Cottonwood Basin-Verde River	7
150602010707	150602010710	39147.2	158.42	Mint Wash	1
150602020401	150602020404	20517.06	83.03	Bull Basin Canyon-Verde River	2
150602020203	150602020211	37553.18	151.97	Meath Wash	2
150602010101	150602010104	14460.54	58.52	Trible Tank	1
150602010403	150602010406	26154.42	105.84	Seven Ranch Tank-Partridge Creek	1
150602030505	150602030506	9317.19	37.71	South Fork Sheep Creek	7
150602010701	150602010708	11827.04	47.86	Humphrey Wash	1
150602010608	150602010609	25128.41	101.69	Maverick Tank-Big Chino Wash	1
150602010502	150602010503	28980.59	117.28	Pineveta Wash	1
150602030204	150602030207	9490.93	38.41	American Gulch	6
150602030108	150602030110	35734.32	144.61	Middle West Clear Creek	5
150602020502	150602020505	31567.82	127.75	Pumphouse Wash	4
150602010505	150602010802	31320.37	126.75	Peter Lockett Canyon-Partridge Creek	1
150602020306	150602020309	25069.59	101.45	Garland Prairie	2
150602010808	150602010809	9547.34	38.64	Antelope Wash	1
150602020508	150602020511	39923.22	161.56	Middle Oak Creek	4
150602020105	150602020106	23863.39	96.57	Table Mountain	1
150602020704	150602020706	30731.37	124.37	Oak Wash-Verde River	3
150602030308	150602030404	39304.15	159.06	Gap Creek-Verde River	6
150602020613	150602020615	19060.57	77.14	Lower Wet Beaver Creek	5
150602010204	150602010207	17469.71	70.7	Black Mountain Tank	1
150602010107	150602010109	15183.8	61.45	Rhodes Canyon	1
150602030605	150602030708	28347.57	114.72	Lower Sycamore Creek	7
150602030406	150602030409	37688.42	152.52	Tangle Creek	6
150602020607	150602020609	11566.16	46.81	Long Canyon	5
150602020404	150602020406	20338.76	82.31	Wildcat Draw-Verde River	2
150602010404	150602010405	8595.87	34.79	Bunker Tank	1
150602010301	150602010303	14237.41	57.62	Juan Tank Canyon	1
150602010102	150602010104	41755.68	168.98	X I Tank-Aubrey Valley	1
150602030506	150602030509	12956.46	52.43	Sheep Creek	7
150602010702	150602010708	12551.25	50.79	Stringtown Wash-Pine Creek	1
150602010609	150602010802	20014.15	80.99	Big Chino Valley-Big Chino Wash	1
150602030103	150602030104	8529.89	34.52	Toms Creek	5
150602010806	150602010809	29511.05	119.43	Lower Walnut Creek	1
150602020503	150602020505	27357.31	110.71	West Fork Oak Creek	4
150602010603	150602010607	38935.05	157.56	Railroad Canyon	1
150602030109	150602030110	8435.23	34.14	Wickiup Creek	5

150602010809	150602020108	48544.26	196.45	Telephone Tank-Big Chino Wash	1
150602030303	150602030308	25749.74	104.21	Chasm Creek-Verde River	5
150602020707	150602030301	23591.57	95.47	Grief Hill Wash-Verde River	5
150602020509	150602020510	15522.68	62.82	Coffee Creek	4
150602020307	150602020309	31714.64	128.34	Big Spring Canyon	2
150602020106	150602020108	30741.71	124.41	Little Chino Valley	1
150602010207	150602010209	25809.74	104.45	Chino Tank-Big Chino Wash	1
150602030401	150602030404	14812.68	59.94	Houston Creek	6
150602030509	150602030702	34482.05	139.54	Bartlett Reservoir-Verde River	7
150602020614	150602020615	23490.17	95.06	Lower Dry Beaver Creek	5
150602030709	150601060302	18073.18	73.14	McDowell Pass-Verde River	7
150602010108	150602010109	10828.45	43.82	Little Soto Tank	1
150602020301	150602020302	31792.28	128.66	Volunteer Wash	2
150602020608	150602020613	12832.3	51.93	Walker Creek	5
150602010401	150602010402	21833.83	88.36	Martin Dam Draw	1
150602030202	150602030205	18831.06	76.21	Headwaters East Verde River	6
150602020611	150602020612	12542.2	50.76	Jacks Canyon	5
150602010705	150602010708	18706.17	75.7	Long Canyon	1
150602020201	150602020203	10559.07	42.73	Manzanita Tank	2
150602020606	150602020612	26150.17	105.83	Lower Woods Canyon	5
150602030503	150602030507	20273.94	82.05	Horseshoe Reservoir-Verde River	6
150602010407	150602010505	22794.18	92.24	Garden Tank-Partridge Creek	1
150602010803	150602010807	37565.34	152.02	Pine Creek	1
150602010606	150602010608	15204.7	61.53	Lower Turkey Canyon	1
150602030106	150602030108	22905.61	92.7	Home Tank Draw	5
150602020407	150602020702	16076.06	65.06	S O B Canyon-Verde River	3
150602020506	150602020507	11145.56	45.1	Secret Canyon	4
150602020304	150602020305	13738.95	55.6	Sawmill Tank	2
150602020103	150602020104	29520.81	119.47	Upper Lonesome Valley	1
150602030210	150602030404	22597.1	91.45	Lower East Verde River	6
150602030306	150602030307	25250.05	102.18	Hardscrabble Creek	6
150602020310	150602020312	12267.9	49.65	Little LO Spring Canyon	2
150602030603	150602030605	12675.98	51.3	Mesquite Wash	7
150602010105	150602010109	10472.67	42.38	150602010105	1
150602030404	150602030409	27283.14	110.41	Canyon Creek-Verde River	6
150602030706	150602030708	20019.65	81.02	Lousley Hill-Verde River	7
150602020209	150602020210	21993.3	89	Bear Canyon	2
150602020204	150602020211	29263.21	118.42	Upper Hell Canyon	2
150602010708	150602010710	13354.99	54.05	Upper Williamson Valley Wash	1
150602020402	150602020404	12771.28	51.68	Government Canyon	2
150602010402	150602010405	21029.77	85.1	Antelope Tank	1

150602030504	150602030507	21786.94	88.17	Davenport Wash	7
150602010607	150602010608	32677.02	132.24	Purcell Canyon-Big Chino Wash	1
150602010804	150602010807	30756.11	124.47	South Butte-Big Chino Wash	1
150602030205	150602030207	34230.23	138.52	Upper East Verde River	6
150602010503	150602010505	33326.59	134.87	Eightmile Creek	1
150602030107	150602030108	14461.88	58.53	Upper West Clear Creek	5
150602020501	150602020502	19187.59	77.65	Fry Canyon	4
150602020305	150602020309	28475.7	115.24	Pitman Valley-Scholz Lake	2
150602010601	150602010607	11066.99	44.79	Shorty Tank	1
150602010807	150602010809	9760.81	39.5	Red Hat Tank-Big Chino Wash	1
150602020705	150602020707	15973.45	64.64	Cherry Creek	5
150602030301	150602030303	19437.49	78.66	Copper Canyon-Verde River	5
150602020104	150602020107	33318.03	134.83	Lower Lonesome Valley	1
150602020210	150602020211	17804.45	72.05	Grindstone Wash	2
150602030707	150602030709	8591.11	34.77	Thompson Peak	7
150602030307	150602030308	29829.73	120.72	Lower Fossil Creek	6
150602010205	150602010207	19010.74	76.93	Sheep Ranch Tank-Big Chino Wash	1
150602030701	150602030703	33280.54	134.68	Camp Creek	7
150602030407	150602030409	19438.07	78.66	Sycamore Creek	6
150602020609	150602020613	23113.68	93.54	Upper Wet Beaver Creek	5
150602010302	150602010303	30870.38	124.93	Johnson Creek	1
150602020313	150602020314	8892.9	35.99	Cedar Creek	2
150602030507	150602030509	28416.88	115	Buck Basin-Verde River	7
150602020604	150602020609	17941.07	72.6	Brady Canyon	5
150602030208	150602030210	12795.85	51.78	Rock Creek	6
150602030104	150602030107	9935.76	40.21	Clover Creek	5
150602010604	150602010606	9626.26	38.96	Road Canyon	1
150602020405	150602020406	10850.73	43.91	Railroad Draw	2
150602020504	150602020508	41209.2	166.77	Munds Canyon	4
150602010801	150602010804	13898.75	56.25	Big Dam Tank	1
150602020101	150602020107	15925.37	64.45	Willow Creek-Willow Creek Reservoir	1
150602030304	150602030307	8516.25	34.46	Mud Tanks Draw	6
150602030101	150602030105	22848.57	92.46	Upper Willow Valley	5
150602020702	150602020704	28490.18	115.3	Mescal Gulch-Verde River	3
150602020601	150602020606	17564.54	71.08	Bar M Canyon	5
150602010103	150602010104	7453.08	30.16	Crater Canyon	1
150602010208	150602010209	18008.69	72.88	Hoffman Tank	1
150602020207	150602020211	14383.6	58.21	Wagon Tire Wash	2
150602020302	150602020308	20412.62	82.61	Government Prairie	2
150602030501	150602030503	25960.57	105.06	Deadman Creek	6
150602030704	150602030706	26536.73	107.39	Malpais Canyon-Verde River	7

150602010202	150602010205	22752.45	92.08	Little Red Lake-Big Chino Wash	1
150602030408	150602030409	9800.41	39.66	Horse Creek	6
150602010706	150602010708	22851.02	92.47	Hitt Wash	1
150602030203	150602030205	22506.12	91.08	Webber Creek	6
150602020202	150602020204	11201.25	45.33	Devil Dog Canyon	2
150602020612	150602020614	17902.67	72.45	Upper Dry Beaver Creek	5
150602020314	150602020407	30694.5	124.22	Lower Sycamore Creek	2
150602020605	150602020612	17035.52	68.94	Rattlesnake Canyon	5
150602010501	150602010505	18885.12	76.43	Mexican Tank	1
150602020406	150602020407	37128.84	150.26	Horseshoe Canyon-Verde River	2
150602010605	150602010606	26483.95	107.18	Upper Turkey Canyon	1
150602010802	150602010804	30269.99	122.5	Limestone Tank-Big Chino Wash	1
150602020507	150602020511	34420.71	139.3	Dry Creek	4
150602030102	150602030105	18290.49	74.02	Long Valley Draw	5
150602030209	150602030210	15265.72	61.78	The Gorge	6
150602020703	150602020706	15469.47	62.6	Black Canyon	3
150602020602	150602020606	12680.16	51.31	Upper Woods Canyon	5
150602010106	150602010109	44278.48	179.19	Last Chance Tank-Aubrey Valley	1
150602010209	150602010607	25301.19	102.39	Fox Dam-Big Chino Wash	1
150602030502	150602030503	28315.82	114.59	Lime Creek	6
150602030705	150602030708	9995.4	40.45	East End	7
150602030604	150602030605	32909.79	133.18	Middle Sycamore Creek	7
150602010203	150602010205	13128.05	53.13	150602010203	1
150602020208	150602020210	21696.2	87.8	M C Canyon	2
150602030405	150602030409	24156.5	97.76	Wet Bottom Creek	6
150602020403	150602020406	18485.77	74.81	Munds Draw	2
150602020205	150602020211	9894.12	40.04	Limestone Canyon	2
150602010405	150602010407	28742.33	116.32	Big Aso Tank	1
150602020311	150602020314	29882.56	120.93	Tule Canyon	2
150602010703	150602010708	18178.15	73.56	Horse Wash	1
150602010805	150602010806	22864.84	92.53	Upper Walnut Creek	1
150602030206	150602030210	30726.71	124.35	Pine Creek	6
150602010504	150602010505	18401.16	74.47	McIntyre Canyon	1
150602010709	150602010710	23171.8	93.77	Mud Tank Wash	1
150602030110	150602030301	18885.28	76.43	Lower West Clear Creek	5
150602010602	150602010607	13088.96	52.97	Quintanna Tank	1
150602020706	150602020707	20080.46	81.26	Hayfield Draw-Verde River	5
150602020308	150602020312	24521.75	99.24	Volunteer Canyon	2
150602020510	150602020511	30849.63	124.84	Spring Creek	4
150602030302	150602030308	17656.18	71.45	Sycamore Canyon	5
150602020107	150602020108	39918.13	161.54	Lower Granite Creek	1

150602020211	150602020404	22854.88	92.49	Lower Hell Canyon	2
150602030402	150602030403	16784.48	67.92	Middle Red Creek	6
150602020615	150602020707	7583.78	30.69	Beaver Creek	5
150602010206	150602010209	7152.76	28.95	Quarry Tank	1
150602030708	150602030709	13352.42	54.04	Fort McDowell-Verde River	7
150602030601	150602030604	39535.58	159.99	Upper Sycamore Creek	7
150602010109	CLOSED BASIN	50822.9	205.67	Camel Tank-Aubrey Valley	1
150602030702	150602030703	18769.62	75.96	Indian Spring Wash-Verde River	7