COLORADO RIVER RECOVERY PROGRAM
FY-2008-2009 PROPOSED SCOPE OF WORK for: **Project #:** 85F
Gunnison and Green River Sediment Monitoring

Lead Agency: U.S. Fish and Wildlife Service

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Category:
___ Ongoing project
_X_ Ongoing-revised project
___ Requested new project
___ Unsolicited proposal

Expected Funding Source:
_X_ Annual funds
___ Capital funds
_X_ Other

I. Title of Proposal:

Gunnison and Green River Basin Sediment Monitoring and Evaluation Program Statement of Work for FY 2008 and FY 2009.

II. Relation to RIPRAP:

General Recovery Program Support Action Plan I.A.3&4
Gunnison River Action Plan: 1.A. Identify fish habitat and flow needs
Green River Action Plan: 1.A. Identify fish habitat and flow needs

III. Study Background/Rationale and Hypotheses:

Underlying geomorphic processes relevant to the formation and maintenance of backwater habitats are relatively poorly understood, particularly the effects of peak-flow magnitude and duration; sediment deposition and erosion; base-flow magnitude and variability; and antecedent conditions on habitat availability and conditions. Knowledge of sediment dynamics in important river reaches is critical to understanding the effects of flow regimes on endangered fish habitats.

Based upon a report entitled "Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin" (LaGory et.al, 2003), the Recovery Program requested proposals to conduct the sediment monitoring element of a Connected Backwaters Project, which also includes a physical habitat monitoring element involving topographic measurements of selected backwaters and adjacent exposed sandbars in each of six river reaches. After review by the geomorphology peer review panel and the Biology Committee, this physical habitat-monitoring element of the project was deferred. However, installing and operating sediment samplers in conjunction with existing streamflow gages were found to be important to supplement and expand existing sediment knowledge.

Beginning in 1998, the Recovery Program and USGS began a 5-year program of sediment data collection for the Yampa and Green Rivers (Elliot and Anders, 2004). Included in Elliot and Anders are sediment-transport equations for suspended load, bedload, total-sediment load, and total-sediment load by hydrograph season. For example, 40 suspended-sediment and 40 bedload measurements were made at the Green River near Jensen, Utah, at discharges ranging from 965 ft^3/s to 22,000 ft^3/s. These data included 18 measurements during the rising-limb hydrograph season and 18 measurements during the recessional- or falling-limb hydrograph season.

While periodic sediment-transport data have been collected and sediment-transport equations adequate for sediment-budget estimation have been derived for the Green River near Jensen (Elliott and Anders, 2004) no daily-sediment data have been collected. Collection of daily sediment records and associated suspended-sediment size analysis can be used to provide the basis for comparison of sediment loads computed using daily samples and sediment loads computed using the sediment-transport equations of Elliott and Anders (2004). Their sediment-transport equations are based on periodic sediment data and represent average sediment-transport conditions in a river. The average condition defined by the equations may not adequately represent episodic sediment transport and sediment concentrations that occur before or after the snowmelt hydrograph. Sediment transport characteristics in the Green River during periods of early snowmelt runoff and during rainfall runoff are usually not well defined by the average condition represented by the sediment-transport equations. The collection of daily sediment records and analysis of the distinction between sediment records computed using the two methods would be an important guide in determining sediment data collection needed to support instream habitat considerations. In addition, collection of daily suspended-sediment data and the associated periodic sediment samples will be useful to improve existing sediment equations by supplementing existing periodic-sampling data.

Based upon a cursory review of existing Gunnison River data sources by Pitlick and others (1999), sediment data comparable to that available for the Green River at Jensen are not available for the Gunnison River near Grand Junction (here in after called the Whitewater gage). The sediment data available for the Whitewater gage are limited to periodic suspended-sediment concentrations collected between 1959 and 1999. A limited amount of sediment-size data, mostly percent of sample finer than 0.062 millimeters, is available at

this site. Therefore the development of sediment-transport equations similar to those developed for the Green River near Jensen would be limited to suspended sediment concentration and perhaps percent of sample finer than 0.062 millimeters. Adequate sediment-size data are needed to develop sediment-transport equations for various sediment-size classes. Similar to the Green River near Jensen, the collection of daily sediment records and the development of sediment-transport equations will allow for analysis of the differences between sediment records computed using each method and would be an important guide in determining sediment data collection needed to support instream habitat considerations. The Green River near Jensen represents sand-sized bed sediment and the Whitewater gage represents mostly cobble-sized bed sediment. No bedload samples have been collected at the Whitewater gage. Bedload discharge will, in lieu of the collection of bedload samples, be estimated for the Whitewater gage using published empirical sediment-transport equations (Einstein, 1950).

Based upon discussion with the Biology Committee, Argonne National Laboratory, and other interested individuals, the USGS was requested to submit a proposal to implement sediment sampling at two locations believed to be important to support future habitat monitoring work and to address key uncertainties in existing flow recommendations for the Green and Gunnison Rivers. The two locations are 09152500 Whitewater gage (0.5 miles south of the town of Whitewater, Colorado on the Gunnison River) and 09261000 Green River near Jensen, Utah.

IV. Study Goals, Objectives, End Products:

A. Goals:

The goal of the sediment monitoring program is to provide information with which to evaluate changes in the magnitude, timing, and size distribution of sediment delivery to the Gunnison and Green River systems and their potential effects on the riverine ecosystem, specifically as they relate to recovery of the endangered fishes.

B. Objectives:

The primary objective of this sediment-monitoring project is to address key uncertainties in priority reaches of the Colorado, Gunnison and Green Rivers relevant to the role of streamflow and sediment transport on the formation and maintenance of backwater habitats and spawning bars[1]. A secondary objective is to collect necessary sediment data to aid in the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir.

[1] While spawning bars were not emphasized by decision makers in 2003 they were ranked high in the priorities report LaGory 2003 and data collection to address spawning bar issues need to be collected simultaneously with data needed for backwater habitat studies.

1. A retrospective analysis of historic sediment data will be done to determine the availability of historic sediment data for the key sites on the Colorado, Gunnison, and Green Rivers. This objective also includes an evaluation of the data to determine their utility for developing sediment-transport equations **(These were completed and presented at the habitat workshop in March 2005).** In addition, an evaluation of trends in sediment transport, and how variations (wet vs. dry years) in annual hydrographs affect sediment transport will be included in the SIR **(to be written in FY 2009)**.

2. To support the evaluation of the effects of streamflow and sediment movement on the morphometric and bed material characteristics of Gunnison and Green Rivers.

3. Determine if there is any distinction between sediment load estimates computed from daily sediment data, sediment transport equations, and empirical bedload transport equations.

4. Evaluate the dynamics of sediment movement in the study reaches by collecting and analyzing data to compute sediment load, including suspended sediment using daily samples and sediment transport equations. Water-surface slope and bed-material samples will be collected at two sites to support bedload calculations. These data will be collected at the Whitewater gage and the Green River near Jensen Utah (Jensen). These sites represent the range in sediment conditions found in other habitat monitoring reaches (primarily cobble bottom in the Gunnison R. at Whitewater and a sand cobble mixture, primarily sand, found in the Green R. near Jensen).

5. Collect necessary topology data near the Jensen site for use in a Surface Water Modeling System (SWMS) Demonstration Project to determine the suitability of this type of modeling of sediment transport as it relates to current and future efforts to monitor habitat for the endangered fishes. An added utility of the proposed work is the opportunity, at a later date, to incorporate output from the SMWM into existing habitat models to further relate streamflow and sediment transport to recovery efforts for the endangered fishes.

6. Collect water-surface elevation, channel cross-section, and streambed sediment-size data from the Gunnison River at Delta to evaluate incipient motion conditions at which the discharge is sufficient to begin transport of the streambed sediment.

C. End Products:

The end products of this scope of work will be 2 reports prepared by the USGS. A Digital-Data Series Report will present the data collected during the study, and a Scientific Investigations Report will present the interpretive data analysis and sediment-transport equations.

V. Study Area:

The study for the retrospective assessment includes the Colorado River in the vicinity of the 15-mile and 18-mile reaches of the Colorado River in the Grand Valley continuing downstream to the confluence of Green River, the Gunnison River downstream from the confluence of the North Fork of the Gunnison River, and the Green River downstream of the Jensen gage near Jensen, Utah. The suspended-sediment collection will be done at two USGS streamflow gaging sites:
09152500 Gunnison River near Grand Junction, CO (also known as the Whitewater gage), and
09261000 Green River near Jensen, Utah.

The incipient sediment motion assessment will be done for the Gunnison River at Delta, supported with discharge data from USGS streamflow gaging station 09144250 Gunnison River at Delta, Colorado.

VI. Study Method/Approach:

A retrospective analysis of historic sediment data will be done for the key sites on the Colorado, Gunnison, and Green Rivers. This analysis will determine whether sediment-transport relations can be derived from existing data and what additional data may be needed to develop or improve sediment transport equations at these sites. Also, historic data will be evaluated to determine if significant trends exist in sediment transport, and the effect of variations in annual hydrographs (wet vs. dry years) on sediment transport.

This project will establish automated suspended-sediment samplers in two critical reaches of the Upper Colorado River Basin (Whitewater gage on the Gunnison River, and the Green River near Jensen, Utah). Daily suspended-sediment load data at these two sites will provide information needed to evaluate the results of sediment-transport calculations derived using daily and periodic sediment samples (sediment-transport equations). This comparison will provide information needed to determine which method is most cost-efficient and appropriate for use to support habitat investigations.

The MD-SWMS Demonstration will be done through the collection and development of a topological dataset using advanced GPS mapping and Acoustic Doppler Current Profiler (ADCP) bathymetry. The topological dataset, in conjunction with available sediment data, will be used in the MD-SWMS model for a reach of the Green River (near the Green River near Jensen streamflow-gaging station, 09261000) to allow for the hydraulic simulation of sediment-transport and channel-morphologic response to user-defined streamflow conditions.

The incipient sediment motion assessment will be based on data collected in 2008 from the Gunnison River at Delta and will utilize methods successfully demonstrated by Elliott and Hammack (1999, 2000) for the Gunnison River in Black Canyon. Anticipated high peak discharges in the spring of 2008 will facilitate assessment of incipient motion estimates made by previous investigators (Pitlick and others, 1999).

VII. Task Description and Schedule

1. **Retrospective Analysis of Historic Data (completed in FY 2005):** Sediment data for the Colorado River in the vicinity of the 15-mile and 18-mile reaches of the Colorado River in the Grand Valley and downstream to the confluence of Green River, the Gunnison River downstream from the confluence of the North Fork of the Gunnison River, and the Green River near Green River, Utah will be summarized. These data will be used to develop sediment-transport equations, to the extent possible, similar to those developed for the Yampa River, Little Snake River, and the Green River near the Gates of Lodore and the Green River near Jensen, Utah. Also, the effects of the annual streamflow hydrograph on sediment transport will be evaluated. These analyses will help to identify data gaps that would be addressed by sediment sampling done in the support of habitat evaluations.

2. **Site Installation (completed in FY 2005) and Data Collection (FY 2005-07):** The USGS Grand Junction office will be contracted to install and instrument two automatic sediment collection sites. The collection of daily suspended-sediment records will be during mid-March through mid-October (approximately 7 months). These data will be collected at the following USGS gage sites:

09152500 Gunnison River near Grand Junction (also known as the Whitewater gage), Colorado
09261000 Green River near Jensen, Utah.

3. **Surface Water Modeling System (SWMS) Topology and Model Demonstration (completed early FY 2007):** To address the issue of endangered fish habitat, the USGS will develop a topological dataset and water-level elevation dataset sufficient for input into the Surface Water Modeling System (SWMS) and use of the SWMS for hydraulic simulation of sediment-transport and channel-morphologic response to user-defined streamflow conditions. A preliminary analysis of this model will be completed to demonstrate the utility of SWMS and a sediment mobility model solution will be created to aid the U.S. Fish and Wildlife Service (USFWS) in the evaluation of Service flow recommendations for the Flaming Gorge Reservoir, as they relate to recovery efforts for the endangered fishes.

4. **Incipient Motion of Sediment, Gunnison River at Delta**:
Incipient sediment motion in the Gunnison River at Delta will be assessed with data collected between the spring peak runoff and the low-flow period in the summer of 2008. Data collection activities will include determination of the peak-flow water-surface elevation and slope, cross-section and longitudinal-profile surveys, discharge measurements, photography, and bed-material sediment size measurements. Incipient-motion analysis will be based on the methods of Elliott and Hammack (1999, 2000) that use the critical-shear stress of sediment in the Delta reach and an appropriate dimensionless (Shields) shear stress. Analysis of the data will be performed after the last data collection site visit. Results of the incipient motion analysis will be included in the USGS interpretive report discussed in the following section.

5. **U.S. Geological Survey Reports (FY 2008-2009):**

In Fiscal year 2008, following the third year of data collection, the USGS will prepare a Digital-Data/Data Series Report (data report) with tables containing available daily mean suspended-sediment load and concentration, concentration and particle-size data from periodic and point suspended-sediment samples, as well as bed-material size information; with a description of the collection and data-processing methodologies. This report will be similar to the annual data report (Crowfoot and others, 2002). In addition, the data report will include appendices containing the topological dataset and water-level elevation dataset from the MD-SWMS modeled reach along the Jensen razorback spawning bar.

In Fiscal year 2009, the USGS will prepare a Scientific Investigations Report (SIR) to summarize the interpretive findings of the study. This report will be similar in format to John Elliott's report on the Yampa and upper Green R. (Elliott and Anders, 2004) and will include the outlined topics listed below:

1) Retrospective assessment:

Summarize finding from the retrospective analysis of sediment data for key reaches of the Colorado, Gunnison, and Green Rivers (completed in 2005). These analyses will help to identify data gaps that can be addressed by future sediment sampling done in the support of habitat evaluations. This completed task includes an evaluation of the data to determine their utility for developing sediment-transport equations. To the extent possible, transport equations were produced similar to those developed for the Yampa River, Little Snake River, and the Green River near the Gates of Lodore and the Green River near Jensen, Utah.

In FY 2008-09, these equations will be revisited; and applicable sites will be updated with the data from the data-collection portion of the study (3 years of daily samples at Gunnison R. near Grand Junction, Colorado; and Green R. near Jensen, Utah).

Benefits

Although the evaluation of the retrospective assessment of historic data and creation of suspended-sediment transport equations are complete, there is still a need to revisit these equations based on new information gleaned from the 2005-08 data collection efforts. A preliminary assessment of the 2005-08 data demonstrates that the objectives of previous data collection efforts have focused on collecting datasets to determine average sediment-flux values at a coarse time scale, predominantly annual or seasonal totals (more focused on the effects on the snowmelt runoff hydrograph). The 2005-08 dataset is different in that the objective to characterize transport during the year also includes a focus on issues from a habitat perspective. This new focus produced a data set that characterizes sediment transport during summer base flow conditions and

monsoon rain events, as well as the snowmelt runoff hydrograph. Preliminary assessment of these data seem to indicate the need to separate the transport equations into more than one regression equation i.e. Rising limb, falling limb, and monsoon transport equations each differing significantly enough to warrant the use of more than a single equation with seasonality or 'dummy variables' (dummy variables shift the equation intercept, not regression slope). The use of multiple equations will result in a more accurate transport equation that better fits the observed seasonality of the sediment transport.

2) Sediment-transport characterization:

A characterization of the magnitude, timing, and size distribution of sediment delivery to the Colorado, Gunnison, and Green River systems will be done using the sediment loads characterized by the daily suspended-sediment record, independent variable used in the generation of sediment-transport equations from the retrospective assessment, and analysis of sediment loads. This characterization will aid the Recovery Program's evaluation of how streamflow and sediment transport relate to the formation and maintenance of backwater habitats and spawning bars and will provide them with information needed for the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir.

Benefits

To support the objective to refine/assess current Service-flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir a characterization of suspended-sediment transport is needed to understand how streamflow magnitude and seasonality relate to sediment transport and habitat. An evaluation of the variables used in each transport equation can provide insight into how streamflow relates to sediment transport, what other processes are important, and limitations of the application of transport equations for these purposes. The determination of targeted peak intensities by USFWS Service flow recommendations is further improved with the comparison of observed responses from the available daily suspended-sediment record at Jensen and Whitewater. These observations strengthen assessment of target Service flows that protect water storage while still meeting habitat objectives. Answers to questions concerning peak-duration recommendations are limited to characterization of transport from the comparison of the observed daily loads 2005-08 at the Jensen and Whitewater gages.

3) MD-SWMS analysis of the Green River razorback spawning bar – Case Study:

MD-SWMS will be used to analyze sediment-transport characteristics at the Green River razorback spawning bar near Jensen, UT (completed early 2007). This analysis will provide modeled simulation of sediment transport characteristics for observed and simulated streamflows. These simulations can provide insight into the mechanics (hydraulics) of sediment-transport on the spawning bar habitat as they relate to varying streamflows.

Benefits

Incorporation of this Case Study into the SIR provides commonality between streamflow, sediment transport, and spawning habitat which provides another important perspective that can be used to refine/assess current Service-flow recommendations for the Flaming Gorge Reservoir.

4) Sediment-monitoring methodology comparison:

A comparison of the results of sediment-transport calculations derived using daily (automatic sediment samplers) and periodic sediment samples (sediment-transport equations) will be done. This analysis will be done to determine the differences in using these two methods. This comparison will provide information needed to determine which method is most cost-efficient and appropriate for use to support habitat investigations.

Benefits

The comparison of these two sediment data-collection methods in this SIR will provide the Recovery Program with information concerning the appropriate uses, limitations, and level of accuracy of each method. A discussion of the range of appropriate time scales for estimates as well as an explanation of the process used to calculate the values. This description will provide information needed to determine the appropriate method for future applications or data-collection efforts.

5) Incipient sediment motion analysis:

Sediment and geomorphic data and results of the incipient sediment motion analysis for the Gunnison River at Delta, CO, will be summarized.

Benefits

The proposed analysis, based on hydraulic conditions arising from the anticipated 2008 peak runoff, will provide a means of verifying earlier estimates of sediment entrainment (incipient motion) potential in the Delta reach. Also, a comparison of the 2008 substrate (streambed) conditions will be made to previous assessments (Pitlick and others, 1999). This component of the study will provide information critical to determining "flushing flows" needed to entrain the streambed gravel, a condition necessary to remove finer sediment from interstitial areas.

VIII. Deliverables, Due Dates, Budget by Fiscal Year:

FY 2006-2008 Budget Estimate:

FY 2006

Funding Source	FY2006 Total
Argonne National Laboratory	$15,000
Recovery Program	$117,000
State of Wyoming	$24,000
USGS Coop/DOI Cost-share	$13,000
Total	$169,000

FY 2007

Funding Source	FY2007 Total
Recovery Program	$107,600
State of Wyoming	$24,900
USGS Coop/DOI Cost-share	$22,500
Total	$155,000

FY 2008

Deliverables: USGS Publication, Digital-Data Series Report

FY 2008 Budget Detail			
FY 2008 Costs:			
		USGS In-kind	Comments
FY2008			
Task 1 - Program Management			
Proj. mgr GS-11 ($34.49/hour; 200 hours)	$8,002		
Task Subtotal	**$8,002**		
Task 2 - Data Analysis			
Hydrologist GS-11($34.49/hour; 78 hours)	$2,690		
Hydrologist GS-9 ($27.73/hour; 160 hours)	$4,437		
Hydrologist GS-7 ($25.69/hour; 200 hours)	$5,138		
Task Subtotal	**$12,265**		
Task 3 - Digital-Data Series Report			
Hydrologist GS-11($34.49/hour; 322 hours)	$11,106		
Hydrologist GS-9 ($27.73/hour; 52 hours)	$1,442		
Hydrologist GS-7 ($25.69/hour; 132 hours)	$3,391		
Publication Costs ($87.50/hour; 140 hours)		*$12,250**	**Costs not included in funds request*
Printing Costs		*$4,000**	**Costs not included in funds request*
Task Subtotal	**$15,939**	***$16,250****	**Costs not included in funds request*
FY 2008 Task TOTAL	**$36,206**	***$16,250****	**Costs not included in funds request*
Science Center Overhead 16.7%	$6,046		
Headquarters Assessment 12%	$4,345		
Facilities Assessment 12.174%	$4,408		
Science Support 36%	$13,034		
TOTAL	**$64,038**	***$36,605****	**Costs not included in funds request*
Total	**Use $64,000**		

FY 2008 Budget Detail: Incipient-Sediment Motion Analysis			
FY 2008 Costs:			
		USGS In-kind	Comments
FY2008			
Task 1 - Program Management			
Proj. mgr GS-13 ($57.43/hour; 26 hours) JGE	$1,494		
Task Subtotal	**$1,494**		
Task 2 - Data Collection			
Hydrologist GS-13($57.43/hour; 50 hours) JGE	$2,872		
Hydrologist GS-12 ($52.39/hour; 29 hours) GPI	$1,520		
Hydrologist GS-11 ($40.77/hour; 40 hours) SPA	$1,631		
Hydrologist GS-7 ($26.18/hour; 40 hours) RWW	$1,048		
Hydrologist GS-5 ($16.92/hour; 24 hours) Hayden	$407		
Task Subtotal	**$7,478**		
Task 3 - Data Analysis			
Hydrologist GS-13($57.43/hour; 48 hours)	$2,757		
Task Subtotal	**$2,757**		
FY 2008 Task TOTAL	$11,729		
Science Center Overhead 16.7%	$1,959		
Headquarters Assessment 12%	$1,408		
Facilities Assessment 12.174%	$1,428		
Science Support 36%	$4,223		
TOTAL	**$20,747**		
Total	**Use $20,500**		

*Projected printing and publication costs that will be covered by the USGS as In-kind services (Since initial program proposal and inception in 2004, USGS has started charging printing and publications costs directly to projects).

FY 2009

Deliverables: USGS Publication, Scientific Investigations Report

FY 2009 Budget Detail			
FY 2009 Costs:			
		USGS In-kind	Comments
FY2009			
Task 1 - Program Management			
Proj. mgr GS-11 ($36.17/hour; 200 hours)	$9,404		
Task Subtotal	**$9,404**		
Task 2 - Scientific Investigations Report			
Hydrologist GS-13($58.20/hour; 50 hours)	$2,910		
Hydrologist GS-11($36.17/hour; 830 hours)	$30,021		
Hydrologist GS-9 ($29.07/hour; 210 hours)	$6,105		
Hydrologist GS-7 ($26.94/hour; 230 hours)	$6,198		
Supplies	$550		
Publication Costs ($91.80/hour; 160 hours)		*$14,688**	**Costs not included in funds request*
Printing Costs		*$2,000**	**Costs not included in funds request*
Task Subtotal	**$45,784**	***$16,688****	**Costs not included in funds request*
Task 3 - Project Archive			
Proj. mgr GS-11 ($36.17/hour; 40 hours)	$1,447		
Proj. mgr GS-7 ($26.94/hour; 40 hours)	$1,078		
Task Subtotal	**$2,524**		
FY 2009 Task TOTAL	**$57,712**	***$16,688****	**Costs not included in funds request*
Science Center Overhead 16.7%	$9,638		
Headquarters Assessment 12%	$6,925		
Facilities Assessment 12.174%	$7,026		
Science Support 36%	$20,776		
TOTAL	**$102,078**	***$38,200****	**Costs not included in funds request*
Total	**Use $102,000**		

*Projected printing and publication costs that will be covered by the USGS as In-kind services (Since initial program proposal and inception in 2004, USGS has started charging printing and publications costs directly to projects).

IX. Budget Summary FY 2008-2009 Funding

Funding Source	FY 2008
Recovery Program - BOR	$19,700
State of Wyoming	$25,647
USGS Coop/DOI Cost-share	$18,653
USGS In-kind (Costs not included in funding request)	*$36,600**
Total	$64,000

Funding Source: Incipient Motion Analysis	FY 2008
Recovery Program - BOR	$19,000
USGS DOI Cost-share	$1,500
Total	$20,500

Funding Source	FY 2009
Recovery Program - BOR	$53,700
State of Wyoming	$26,400
USGS Coop/DOI Cost-share	$21,900
USGS In-kind (Costs not included in funding request)	*$38,200**
Total	$102,000

*Projected printing and publication costs that will be covered by the USGS as In-kind services (Since initial program proposal and inception in 2004, USGS has started charging printing and publications costs directly to projects).

X. Reviewers:

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XI. Literature Cited:

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