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Expert Report on Review of Coeur d'Alene Lake Elevation Claims

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Watershed Systems Group, INC.

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About the Author: Dr. Thomas B. Hardy, PhD

I hold a B.S. Education, B.S. Biology, M.S. Aquatic Ecology, and PhD in Civil and Environmental Engineering. I was the Director of the Institute for Natural Systems Engineering (1988 – 2000) at the Utah Water Research Laboratory at Utah State University until I retired from USU in 2009. I was also the Associate Director of the Utah Water Research Laboratory during my final 10 years. In, 2009 I took a Senior Lecturer position at Texas State University in the Department of Biology and as Chief Science Officer at the River Systems Institute. I retired in 2020 as a tenured full professor and awarded Distinguished Professor Emeritus status after holding the inaugural Meadows Center for Water and the Environment Endowed Professorship for Environmental Flows. I was awarded the Instream Flow Council Lifetime Achievement Award and I was a founding member of the Ecohydraulics Committee of the International Association for Hydro-Environment Engineering and Research and was awarded the Committee's Honorary Fellow designation.

I am an internationally recognized expert in instream flow and water level conservation assessment methods and I have collaborated with national instream flow and river restoration programs in the United States, Canada, Mexico, United Kingdom, Norway, Germany, Spain, Portugal, Australia, New Zealand, South Africa, South Korea, and Japan. As an invited expert, I made material contributions to the European Union Water Framework Directive COST 626 network and its EU publications on state of the art in data collection, modeling, and integration of instream flow and water level conservation metrics within the EU and broader international community. I served on the National Academy of Science Committee that reviewed the proposed Texas Instream Flow Program, and headed the team that reviewed the 30+ instream flow and water level conservation studies conducted over the subsequent 10 years as part of the mandated adaptive management process.

My 40+ years of multidisciplinary based research and applied studies has spanned a wide array of fundamental and applied multidisciplinary research across all five Instream Flow Council (IFC; Annear et al. 2004) science elements: hydrology, geomorphology, biology, connectivity, water quality and their integration for evaluating both instream and water level conservation needs across many different systems and target species. In that process, I have direct experience in modeling lake and reservoirs for hydrodynamics, water quality, temperature, aquatic plant, macroinvertebrate, and fisheries dynamics supported by extensive use of remote sensing and GIS based spatial modeling/analyses. This extensive research and applied experience provides the basis to evaluate the lake level claims across all five IFC science elements: hydrology, geomorphology, biology, connectivity, and water quality and ultimately their integration in support of the claim amount and structure.

BACKGROUND

I was asked by the Coeur d'Alene Tribe (CDA Tribe) to provide a technical review of the claim structure and supporting documentation used in the claim development process provided by the Department of Justice (DOJ) and its consultant Klineshmidt Associates (Team) for Coeur d'Alene Lake (Amended Claim No. 95-16704). The stated purpose of the Coeur d'Alene Lake claim is to provide historical monthly lake elevations necessary to '*preserve, restore, and sustain*' *culturally important plants, rearing fish, and waterfowl habitats supporting these populations*

within the lake (CDS Lake Claim Development Report, Shelly et al., 2024). The Lake claim supports the Reservation's hunting fishing, gathering and cultural purposes.

I have specifically focused on the analytical frameworks and rationale employed within each report to select data, analytical methods, their application, modeling systems (calibration, validation, simulation) and results, as well as their integration across the five IFC elements. As such, my review focuses on if the underlying data utilized support the selected methodological approaches and were they selected rationally and objectively applied and interpreted within what in my professional opinion would be considered acceptable standard engineering and science practice for each IFC science element and their integration.

OVERVIEW AND SUMMARY CONCLUSIONS

These series of technical reports lay out the application of various methods across the five IFC science elements: hydrology, geomorphology, biology, connectivity, and water quality and ultimately the integration of the data, analysis, and modeling results across these five elements in support of the final claim amounts and structure. Addressing each of these IFC elements (in addition to the legal, institutional, and policy elements) is recognized by the IFC as necessary considerations when assessing flow regimes or water level conservation needs. Addressing each of these IFC elements in the assessment process underpin the credible application of science and engineering across each element and ultimately their integration (see <https://www.instreamflowcouncil.org/>).

The component data, analyses, modeling approaches, and interpretation within each technical study were summarily found to represent a competent application of accepted standard science and engineering principles. In particular, the clear integration across all five IFC science elements to generate a final claim structure and amounts is found to be objective, reproducible, and clearly supported by the data, study results, and germane literature for each IFC technical element and their integration.

There were clear linkages between selection of datasets, data reduction approaches, analyses and modeling that specifically targeted key lake elevation dependent resource needs (fish, plants, waterfowl) on a monthly basis. The review and use of available datasets and literature resources was parsimonious and pragmatically focused in supporting each technical element and quantification of identified tribal resource life history needs upon which the integrated flow claims were developed.

The DOJ Team structured its analysis from the integration of spatial topographic datasets to generate the necessary lake bathymetry at spatial resolutions suited to the evaluation of lake elevations for tribal target resource needs. It is recognized that legal, institutional, and policy constraints limited the spatial assessments to reservation lands (areas) in lieu of the entire lake system when integrating the biological based assessments.

Federal experts estimated suitable habitat values on a monthly basis for fish, plant, and waterfowl by estimating lake elevations that encompassed 90 percent of the known monthly habitat variation. This is a conservative approach that ensures the flow regime captures the inherent observed variability and is a pragmatic approach applied across a wide array of disciplines and methods in my experience and an approach I support in resource evaluations.

In my opinion, the technical approach taken to develop the lake bathymetry as well as the approach taken to estimate the resulting hydrology regimes necessary to achieve monthly target lake elevations for protection of quantified tribal resources are not compromised by failure to include the full lake domain. The constrained spatial domain used in the biological assessments likely under estimates to total real ecological value to the proposed lake elevation regime on the identified tribal resources.

I conclude summarily that the overall analysis framework, datasets utilized, analytical and modeling approaches, and interpretation of results within each of the component technical studies in combination of the clear 'vertical' integration across all five IFC science elements in terms of quantified resource needs for waterfowl, fish, and plants that were harvested by the tribe to generate a final seasonal claim structure unequivocally supports the claimed amounts. In this context, vertical integration refers to the conceptional and analytical approach taken by the Team in which the component analyses targeting specific tribal resource habitat needs for waterfowl, fish, and plants were simultaneously integrated across time and space to develop a lake elevation regime that addresses the concurrent needs of all these resources on a monthly basis.

I consider these lake elevation regimes to be objective, reproducible, clearly supported and linked to the underlying data, study results, and reference literature for each IFC technical element and their integration.

REVIEW

My review considered the following material. These series of reports represent data, analyses, and modeling results that build upon the physical characterization of the lake environment (No.1) when integrated with the lake hydrology (No. 6) that served as the template to integrate the spatial and temporal analyses of the thermal regime (No. 2) and informed the analysis and integration of results from three resource characterization reports (No. 3, 4 and 5). These component assessments were systematically integrated in the summary lake claim report (No.7) that established the Coeur d'Alene Lake elevation claims on a monthly basis.

No.1: CDA Lake Bathymetry Report – Zabloutney, J. 2024. Coeur d'Alene Lake Bathymetry and GIS Analysis Report. Expert report prepared by Kleinschmidt Associates for United States Department of Justice, Environmental & Natural Resources Division. Redmond, WA. September.

Provides the physical template necessary to establish lake elevation specific physical habitat distributions in terms of lake depths. It is also the spatial template over which all integrated analyses were undertaken.

No. 2: CDA Lake Temperature Modeling Report - Shelly, A. 2024. Coeur d'Alene Lake Water Temperature Modeling. Expert report prepared by Kleinschmidt Associates for United States Department of Justice, Environmental & Natural Resources Division. Redmond, WA. September.

Provides a rational basis for estimating the spatial and depth-dependent thermal regimes supporting analyses for target tribal resources.

No. 3: CDA Lake Waterfowl Habitat Report - Bohenek, J. 2024. Coeur d'Alene Lake Habitat for Waterfowl. Expert report prepared for United States Department of Justice, Environmental & Natural Resources Division. Denton, TX. September.

Provides the linkage between the literature, available datasets and analyses used to quantify waterfowl feeding guilds (~ differential depths) used to estimate the seasonal habitat quality and quantity.

No. 4: CDA Lake Aquatic Plant Habitat Report - Bohenek, J. 2024. Coeur d'Alene Lake Habitat for Culturally Important Aquatic Plants. Expert report prepared for United States Department of Justice, Environmental & Natural Resources Division. Denton, TX. September.

Provides the linkage between the literature, available datasets, and analyses used to estimate the distribution and characteristics of the aquatic and emergent lake vegetation that provides key habitat characteristics and resources for fish and wildlife species, and support culturally important species gathered by the tribe and are integrated into the assessments.

No. 5: CDA Lake Fish Habitat Report - Gagner, M. 2024. Coeur d'Alene Lake Fish Habitat Report. Expert report prepared by Kleinschmidt Associates for United States Department of Justice, Environmental & Natural Resources Division. Redmond, WA. September.

Provides the linkage between the literature, available datasets, and analyses that quantified the habitat availability for key tribal fish species and rearing life stage habitats across the spatial and temporal domain of the lake.

No. 6: CDA Lake Hydrology Report – Yoder, C. 2024. Coeur d'Alene Lake Water Budget and Estimates of Natural Lake Elevations. Expert report prepared by Kleinschmidt Associates for United States Department of Justice, Environmental & Natural Resources Division. Redmond, WA. September.

Provides the linkage between the literature, available datasets, and analyses used to estimate the relationship between lake elevation and surface area/volumes and underpins the analysis of elevation dependent depths within the lake relied up in the resource characterization reports (No., 2, 3, 4, and 5).

No. 7: CDA Lake Claim Development Report – Shelly, A. (primary author), Bohenek, J., Gagner, M., Yoder, C., and Zabloutney, J. (contributing authors) 2024. Development of Coeur d'Alene Lake Water Rights Claim. Expert report prepared by Kleinschmidt Associates for United States Department of Justice, Environmental & Natural Resources Division. Redmond, WA. September.

Provides the conceptual and analytical frameworks by which the component results from the physical (depth), thermal, and biological resource needs are integrated into a single comprehensive assessment of the required seasonal lake elevation regime based on ensuring that at least 90 percent of the estimated monthly habitat area were protected by the identified lake elevation (inflow regime).

REPORT REVIEW SUMMARIES

CDA Lake Bathymetry Report

My experience suggests that under historical conditions the natural outlet topography of Coeur d'Alene Lake would control the outflow volumes and lake level elevations in response to seasonal inflow patterns in a somewhat predictable pattern with expected inter-annual variations reflecting differences in upstream precipitation variability due to climatic factors. I would expect that the seasonal aquatic and emergent plant community phenologies (life history strategies) would be expressed by seasonal species presence/absence in part reflecting the control imposed by the underlying lake bathymetry-elevation dynamics. These dynamics are import drivers of the spatial distribution and extant of key seasonal lake depths, distribution of aquatic and emergent plant communities in conjunction with near shore thermal profiles (surface and depth dependent profiles) associated with identified suitable habitat characteristics necessary to support culturally important tribal resources of waterfowl, fish, and plants.

The lake bathymetry was derived from application of standard GIS tools and analysis based on available vetted datasets (e.g., LIDAR, bathyametric surveys) at a high spatial resolution. The resolution was clearly capable of supporting the refined spatial analyses of tribal target species habitat characteristics. These bathymetric results established the spatial framework to vertically integrate the spatial and temporal physical characteristics (depths and temperature profiles) as a function of lake elevation. This template allowed the coherent spatial integration of the aquatic and emergent vegetation results and the application of developed habitat suitability relationships for the waterfowl feeding guilds, fish species life stages, and the plant community.

CDA Lake Temperature Modeling Report:

Thermal properties of habitats where temperature differences can vary vertically and longitudinally can regulate habitat quality (e.g., fish) on a seasonal basis. An extensive littoral temperature monitoring dataset supported a robust statistical approach to estimate depth specific thermal regimes across the spatial and seasonal domains evaluated for claims. This permitted the direct reference of these results against analyzed/literature thermal limits and preferences of target fish species and life stages by month. Overall the technical report applied a consistent framework to the analyses that relied on established statistical approaches.

I found that the lake temperature modeling report provided a robust statistical analysis that supported model selection, parameterization, calibration, and validation. In my professional experience, the results provide reasonable estimates of the spatial and temporal thermal regimes that are within expected and defensible levels of resolution and adequately reflect thermal processes throughout the shallow water habitats evaluated.

CDA Lake Waterfowl Habitat Report:

I found that the waterfowl habitat data and analysis represented a pragmatic integration of the available literature on waterfowl habitat use and characteristics. This was combined with a robust statistical analysis of available waterfowl related datasets from the lake that specifically targeted the key lake habitat attributes associated with the established depth-dependent feeding guilds. Guilds represents groups of species that share essentially similar habitat requirements for environmental factors such as depth or temperature, etc. This can effectively allow as single

species/life stage to be used as a representative of the guild to simplify the analyses, interpretation and application of study results. This is a commonly applied technique.

This provided a rational basis for analyses to associate waterfowl feeding guild depths to modeled lake littoral habitat conditions as a function of lake elevations. Integration of the littoral plant community seasonal dynamics that are tied to the seasonal depth regime and suitable habitat access by the three waterfowl guilds is clearly supported in the data and analyses. The application of guilds to simplify species groupings with similar life history requirements is a common practice applied across a wide range of aquatic and terrestrial taxa groups. It is noted that utilization of the diving guild in the final assessment inherently ensures access to suitable habitat areas for the two remaining guilds with shallower water (depth) requirements at a given lake elevation.

CDA Lake Aquatic Plant Habitat Report:

The report provides a robust review of germane literature in support of the statistical analysis of available emergent and submergent vegetation in lake systems and incorporated site specific data from existing lake surveys. The statistical methods are robust and clearly connect the phenology of the seasonal plant dynamics given variations in seasonal lake elevations. These data/results were foundational to support the integrated evaluations such as the importance of access to aquatic vegetation specifically for evaluation of rearing fish habitats (e.g., escape cover and substrate for food production). The analytical approaches, datasets relied upon, the analyses and their interpretation relied upon recognized and accepted approaches that I consider to be within ranges of acceptable practice. The results were integrated with the lake bathymetry data on depths and provided key inputs (vegetation cover) utilized by the fish and life stage rearing habitat assessments. It is further noted that these assessments as applied linked the plant communities that provide culturally important resources that were harvested.

CDA Lake Fish Habitat Report:

The report represents an application of physical habitat modeling principals based on integration of habitat suitability functions of target fish life stages in terms of depth, vegetation cover and water temperature on a spatial and seasonal basis within the lake. The statistical analysis and subsequent habitat suitability relationships that represent the relative suitability across a gradient of depth, vegetation use, and temperature requirements are rational and biologically relevant. The use and interpretation of life history traits such as rearing habitat characteristics and the thermal preference and limits of the target fish species and life stages are supported by the encompassed literature. In my professional opinion, the data, analyses, and subsequent parameterization of the habitat suitability functions used to quantify the relationships between lake elevation, thermal regime, and suitable fish habitat availability is coherent and objective.

CDA Lake Hydrology Report:

I found that development of the natural lake hydrograph and supporting analyses to derive the target monthly lake elevation claims to have followed recognized and accepted application of relevant scientific and engineering principles. The assessment was based on available vetted datasets and followed accepted data reduction and analysis pathways for mass balance around a water body (i.e., lake). The methodologies employed are established and their application consistent with the objectives of the modeling exercise in support of claim development. The

methodological approach for the estimation of required lake inflow volumes is rational and reproducible. It is my opinion, that the integrated hydrology coupled to the monthly lake elevations is rational and credible.

CDA Lake Claim Development Report:

The efficacy of the claim development process is encapsulated in this report which, in my professional opinion, provides a clear and objective 'vertical' integration of the component five IFC science elements of hydrology, geomorphology, biology, connectivity, and water quality that is spatially relevant and directly support of the monthly claim amounts. The report provides a systematic presentation of all the relevant summary findings from each component report in a manner that clearly allows the independent evaluation of how each component part contributed to and is addressed by the integrated flow claims. This provides a clear and defensible justification for the use of the integration of the component analyses to derive credible monthly claim amounts based on the technical underpinnings of the component reports.

CONCLUSIONS

My professional opinion is that the component technical reports applied commonly recognized accepted science and engineering approaches and methodologies. Furthermore, the claim development process competently addressed each of the five IFC science elements in the assessments within the context of the claim development process. In particular their approach to integration of these IFC science elements was objective, rational, reproduceable and the claim amounts and monthly structure follows currently recognized and accepted frameworks encompassing the natural flow paradigms in lake systems.

It is also my opinion that the elevation quantities are sufficient to ensure that the water in the lake will in fact accomplish the stated purpose of the Lake claim (hunting, fishing, gathering and cultural purposes) that will *preserve, restore, and sustain* these resources into the future.

LITERATURE CITED

Annear, T., I. Chisholm, H. Beecher, A. Locke, P. Aarrestad, N. Burkardt, C. Coomer, C. Estes, J. Hunt, R. Jacobson, G. Jobsis, J. Kauffman, J. Marshall, K. Mayes, C. Stalnaker, and R. Wentworth. 2004. Instream flows for riverine resource stewardship, revised edition. Instream Flow Council, Cheyenne, WY. 268 pp.

TEXAS STATE VITA

I. Academic/Professional Background

A. Name and Title

Name: Dr. Thom Hardy

Title: Professor

B. Educational Background

<i>Degree</i>	<i>Year</i>	<i>University</i>	<i>Major</i>	<i>Thesis/Dissertation</i>
PHD	1988	Utah State University	Civil and Environmental Engineering	
MS	1985	University of Nevada, Las Vegas	Biological Sciences	
BS	1978	University of Nevada, Las Vegas	Biology	
BSED	1977	University of Nevada, Las Vegas	Secondary Education	

C. University Experience

<i>Position</i>	<i>University</i>	<i>Comments</i>	<i>Dates</i>
Professor, Department of Biology	Texas State University. San Marcos, TX		2014 - Present
Chief Science Officer, Meadows Center for Water and the Environment	Texas State University. San Marcos, TX		2009 - Present
Research Professor/Senior Lecturer, Department of Biology	Texas State University. San Marcos, TX		2009 - 2014
Associate Director, Utah Water Research Laboratory	Utah State University		2002 - 2009
Professor, Department of Civil and Environmental Engineering	Utah State University		2002 - 2009
Director, Institute for Natural Systems Engineering	Utah State University		1987 - 2009
Associate Professor, Department of Civil and Environmental Engineering	Utah State University	Tenured in 1995	1995 - 2002
Assistant Professor, Department of Civil and Environmental Engineering	Utah State University		1990 - 1995
Research Assistant Professor, Department of Civil and	Utah State University		1988 - 1990

<i>Position</i>	<i>University</i>	<i>Comments</i>	<i>Dates</i>
Environmental Engineering Acting Research Assistant Professor, Department of Civil and Environmental Engineering	Utah State University		1987 - 1988
Research Scientist, Aquatic Biology	University of Nevada at Las Vegas		1980 - 1982

D. Relevant Professional Experience

<i>Position</i>	<i>Entity</i>	<i>Comments</i>	<i>Dates</i>
Principal	Watershed Systems Group, INC		1978 - Present
Principal	Environmental Mapping and Remote Sensing, Inc.		1994 - 1999
Instructor	Computer Techniques, Utah Division of Wildlife Resources		1998
Research Engineer	BIO/WEST, Inc.		1984 - 1987
Project Manager/Aquatic Ecologist	Environmental Consultants, Inc.		1979 - 1985
Research Diver	University of Nevada at Las Vegas Utah Water Research Laboratory		1979 - 1985
Civil Engineer	Twelve-Nine, Inc.		1984
Surveyor	Clark County Engineering Department		1976

II. TEACHING

B. Courses Taught:

Texas State University:

BIO 4299 - UNDERGRAD RES

BIO 4350E - TECHN IN AQUATICS

BIO 5114 - RESEARCH EXPER

BIO 5199B - THESIS

BIO 5214 - RESEARCH EXPER

BIO 5299B - THESIS

BIO 5314 - RESEARCH EXPER

BIO 5399A - THESIS

BIO 5399B - THESIS

BIO 7114 - RESEARCH EXPER

BIO 7199A - DISSERTATION

BIO 7199A - DISSERTN AQUA RES

BIO 7214 - RESEARCH EXPER

BIO 7299A - DISSERTATION

BIO 7299A - DISSERTN AQUA RES

BIO 7303 - RESEARCH

BIO 7360F - APPR AQ RES MODEL

BIO 7360V - TECHN IN AQUATICS

BIO 7399A - DISSERTATION

BIO 7399A - DISSERTN AQUA RES

BIO 7699A - DISSERTATION

BIO 7699A - DISSERTN AQUA RES

Utah State University:

CEE 103 - Digital Computer applications in engineering

CEE 363 - Introduction to Environmental Engineering

CEE 369 - Environmental Systems Engineering

CEE 493/693 - Special Problems in natural systems engineering

CEE 5690/6690 - Natural Systems Engineering

CEE 5700/6700 - Field sampling techniques

CEE 5720/6720 - Natural Systems Modeling

CEE 588 - Senior Design Seminar

CEE 596/696 - Management of Regulated Rivers

CEE 6930 - Special Problems

CEE 693 - Ecology and management of regulated rivers

C. Directed Student Learning (i.e. theses, dissertations, exit committees, etc.):

Member, Master's Thesis, "An Analysis of aquatic vegetation in the San Marcos River using sUAS", Status: Completed. (2021 - Present). Geography, Texas State University.

Student(s): Alexa Lopez, Graduate, MS.

Member, Master's Thesis, "The Impact of Invasive Hypostomus plecostomus on Endangered Texas wild rice *Zizania texana* in the San Marcos River", Status: In Progress. (2016 - Present). University of Houston - Clear Lake.

Student(s): Allison Norris.

Member, Dissertation, "Social Demand for Ecosystem Services of Blue Spaces", Status: In Progress. (2015 - Present). Geography, Texas State University.

Student(s): Graham Daly.

Supervisor / Chair, Master's Thesis, "Comparing Upstream Migration Models of Adult Chinook Salmon (*Oncorhynchus tshawytscha*) in the Klamath River, USA", Status: In Progress. (2015 - Present). Biology, Texas State University.

Student(s): Emily Cowles.

Member, Master's Thesis, "Influence of Recreation on Spatial and Temporal Patterns in Water Quality and Periphyton Growth and their Effect on Texas wild-rice (*Zizania texana*)", Status: In Progress. (2014 - Present). University of Houston- Clear Lake.

Student(s): Rachel Byrne.

Member, Master's Thesis, "Short term responses of nutrient uptake and release of *Eichhornia crassipes*, *Pistia stratiotes*, and *Ceratophyllum demersum* to nutrient pulses via precipitation events in Spring Lake, San Marcos River, Texas", Status: Completed. (2012 - Present). Biology, Texas State University.

Student(s): Kerstin Hoesel.

Member, Dissertation, "The role of life history strategies and drying events for mussel communities: A multiscale approach", Status: Completed. (2020). Biology, Texas State University.

Student(s): Zachary Mitchell, Doctoral, PhD.

Member, Master's Thesis, "DUNE FEATURE EXTRACTION USING IMAGE TEXTURE AND PATCH METRICS", Status: Completed. (December 2019). Geography, Texas State University.

Student(s): Brandon Rose, Graduate, MS.

Member, Master's Thesis, "IDENTIFYING DUNE HABITAT THROUGH THE USE OF REMOTE SENSING CLASSIFICATIONS", Status: Completed. (December 2019). Geography, Texas State University.

Student(s): Lucas Chavez, Graduate, MS.

Member, Dissertation, "Controls on conduit development in a carbonate platform: Quintana Roo, Mexico", Status: Completed. (2016 - December 2019). Biology, Texas State University.

Student(s): Aubri Jenson, Doctoral, PhD.

Member, Dissertation, "DETERMINING THE STATUS AND DISTRIBUTION OF THE EASTERN BLACK RAIL (LATERALLUS JAMAICENSIS) IN COASTAL TEXAS", Status: Completed. (2016 - August 2019). Biology, Texas State University.

Student(s): Amanda Moore.

Member, Dissertation, "WATER IN A CHANGING CLIMATE: MONTANA'S FLATHEAD INDIAN RESERVATION, 1961-2100", Status: Completed. (2015 - August 2019). Geography, Texas State University.

Student(s): Francesco Zignol.

Member, Dissertation, "Examination of Ecophysiology and Trophic Ecology of Epigeal and Hypogean Invertebrates from the Edwards Aquifer", Status: Completed. (2015 - June 2019). Biology, Texas State University.

Student(s): Paravathis Nair.

Member, Master's Thesis, "Effects of stormwaters in Sessom Creek and the San Marcos River, San Marcos, TX: Nutrients, sediment and other contaminants", Status: Completed. (May 2017 - May 2019). Biology, Texas State University.

Student(s): Dalila Loiacomo, MS.

Supervisor / Chair, Dissertation, "Predicting future range expansion of Whooping Crane (*Grus americana*) winter habitat using long-term censure and remotely sensed data", Status: Completed. (2014 - May 2019). Biology, Texas State University.
Student(s): Nikki Davis.

Member, Master's Thesis, "Freshwater mussel biodiversity survey within the Big Thicket National Preserve, Texas", Status: Completed. (2014 - March 2019). Biology, Texas State University.
Student(s): Alison Tarter.

Supervisor / Chair, Dissertation, "Recreation induced impacts on Texas wild rice growth and fitness", Status: Completed. (2018). Biology, Texas State University.
Student(s): Michele Crawford.

Member, Master's Thesis, "Consequences of Long-term Changes in Fish Community on Ecosystem Functioning in a Subtropical", Status: Completed. (2018). Biology, Texas State University.
Student(s): Aine Carroll, MS.

Member, Master's Thesis, "Changes in fish assemblage after disturbance event caused by sudden increase in salinity in a perennial desert stream", Status: Completed. (2018). Department of Integrative Biology, University of Guelph.
Student(s): Carolyn Trombley.

Member, Master's Thesis, "Assessment of Invasive Armored Catfishes (*Pterygoplichthys disjunctivus* and *Hypostomus plecostomus*) Instream Habitat Use in the San Marcos and Buffalo Bayou Watersheds", Status: Completed. (2018). University of Houston - Clear Lake.
Student(s): Kristopher Warner.

Member, Master's Thesis, "Identifying host fish for threatened unionid mussels in Central Texas", Status: Completed. (2017). Biology, Texas State University.
Student(s): Ashley Seagroves.

Member, Master's Thesis, "Evaluating the use of unmanned aerial systems (UAS) in surveying mixed-species waterbird colonies", Status: Completed. (2017).
Student(s): Jared Barr.

Member, Master's Thesis, "Delineating the Springshed of Cave Without a Name", Status: Completed. (2017). Biology, Texas State University.
Student(s): Mark Hiler.

Member, Master's Thesis, "THE RELATIONSHIP BETWEEN BIODIVERSITY AND NUTRIENT RECYCLING BY SUBTERRANEAN INVERTEBRATES IN THE

EDWARDS AQUIFER", Status: Completed. (2016 - August 2017). Biology, Texas State University.
Student(s): Nathan Krupka.

Member, Master's Thesis, "Salmonellae in the Intestine of Hypostomus plectostomus in the San Marcos River", Status: Completed. (2016). Biology, Texas State University.
Student(s): Anna Gates.

Member, Master's Thesis, "Movement behavior of unionid mussels in central Texas", Status: Completed. (2016). Texas State University.
Student(s): Bianca Hernandez.

Supervisor / Chair, Master's Thesis, Status: Completed. (2016). Integrative Studies, Texas State University.
Student(s): Catherine Stumberg, MSIS Environmental SustainabilityM.

Member, Master's Thesis, "Pixel-based and object-based classification methods for surveying wetland vegetation with an unmanned aerial system", Status: Completed. (2016). Geography, Texas State University.
Student(s): Nicholas Villarreal.

Supervisor / Chair, Master's Thesis, "Seasonal and longitudinal investigation of the impacts of recreational activities on aquatic macroinvertebrates community of the San Marcos River", Status: Completed. (2016). Biology, Texas State University.
Student(s): Ovie Shola.

Member, Master's Thesis, "Geochemical Clues to Groundwater Sources of the Pedernales River, Texas", Status: Completed. (2016). Biology, Texas State University.
Student(s): Sarah Zappitello.

Supervisor / Chair, Master's Thesis, "Habitat association of Rainbow Trout in the Canyon Reservoir tailrace", Status: Completed. (2015). Biology, Texas State University.
Student(s): Greg Cummings.

Supervisor / Chair, Master's Thesis, "Seasonal impact of recreation based suspension of turbidity on the macroinvertebrate assemblage of the San Marcos River", Status: Completed. (2015). Biology, Texas State University.
Student(s): Jacob Bilbo.

Member, Master's Thesis, "Potential role of stygobitic species in nutrient dynamics of the Edward's Aquifer in central Texas", Status: Completed. (2015). Texas State University.
Student(s): Lauren Loney.

Member, Dissertation, Status: Completed. (2014). Civil and Environmental Engineering, Utah State University.
Student(s): Omar Alminagorta, PhD.

Member, Master's Thesis, "Habitat characterization of *Zizania texana* in the San Marcos River", Status: Completed. (2014). Geography, Texas State University.
Student(s): Kristina Tolman.

Member, Master's Thesis, "Applications of unmanned autonomous vehicle systems: Mapping salt cedar and change detection of petroleum exploration", Status: Completed. (2014). Geogra, Texas State University.
Student(s): Laura Clark.

Member, Dissertation, "Applications of Bayesian Statistics in Fluvial Bed Load Transport", Status: Completed. (2013). Utah State University.
Student(s): Mark Schmelter.

Member, Master's Thesis, "Influence of connectivity and habtat heterogeneity of fishes in the upper San Marcos River, Texas", Status: Completed. (2013). Texas State University.
Student(s): Kenneth Behen.

Member, Dissertation, "Using Relevance Vector Machines Approach for Prediction of Total Suspended Solids and Turbidity to Sustain Water Quality and Wildlife in Mud Lake", Status: Completed. (2012). Civil and Environmental Engineering, Utah State University.
Student(s): Ahmed Mohamed.

Member, Dissertation, "Using Relevance Vector Machines Approach for Prediction of Total Suspended Solids and Turbidity to Sustain Water Quality and Wildlife in Mud Lake", Status: Completed. (2012). Utah State University.
Student(s): Hussein Batt.

Member, Dissertation, "Analysis of Irrigation Decision Behavior and Forecasting Future Irrigation Decisions", Status: Completed. (2012). Utah State University.
Student(s): Sanyogita Andriyas.

Member, Dissertation, "Variability of Water Storage and Instream Temperature in Beaded Arctic Streams", Status: Completed. (2011). Utah State University.
Student(s): Madeline Merck.

Member, Master's Thesis, "Numerical analysis of rivers using the depth-averaged equations of motion", Status: Completed. (2011). Utah State University.
Student(s): Ben Case.

Member, Master's Thesis, "Relative Importance of Environmental Variables for Spawning Cues and Tributary Use by an Adfluvial Lake Sucker", Status: Completed. (2011). Utah State University.
Student(s): Brian Hines.

Member, Dissertation, "A Systems Approach to Modeling and Impact Assessment in an Urbanizing Watershed", Status: Completed. (2010). Biology, Texas State University.
Student(s): Adrian Vogl.

Member, Dissertation, "Characterizing Ecologically Relevant Variations in Streamflow Regimes", Status: Completed. (2010). Utah State University.
Student(s): Kiran Chinnayakanahalli.

Member, Master's Thesis, "Cyprinid assemblage structure along physical, longitudinal, and seasonal gradients, and life history and reproductive ecology of the Sabine Shiner", Status: Completed. (2010). Texas State University.
Student(s): Casey Williams.

Supervisor / Chair, Dissertation, "Integrating surface and sub-surface flow models of different spatial and temporal scales using potential coupling interfaces", Status: Completed. (2008). Civil and Environmental Engineering, Utah State University.
Student(s): Alphonse Guzha.

Additional Comments: Post Doctoral Research Associate, University of Florida, 2008-2011; Visiting Research Scientist, George-August Goettingen University, Germany, 2011-present.

Member, Dissertation, "Rank-Date Distribution Method (R-D Method) For Daily Time-Series Bayesian Networks And Total Maximum Daily Load Estimation", Status: Completed. (2008). Utah State University.
Student(s): Joon Hee Lee.

Supervisor / Chair, Dissertation, "Virgin River operations optimization model", Status: Completed. (2007). Civil and Environmental Engineering, Utah State University.
Student(s): Leon Basdekas.

Additional Comments: Senior Engineer, Watercourse Engineering, Inc., 2005-2008; Principal Engineer (Water Resources), Colorado Springs Utilities, 2008-present

Supervisor / Chair, Dissertation, "Two-dimensional mobile bed hydrodynamic model for the transport of mixed sediments", Status: Completed. (2006). Civil and Environmental Engineering, Utah State University.
Student(s): Anji Dodd.

Additional Comments: CALFED Science Fellow, Humboldt State University, Arcata, CA, 2005-2008; Senior Environmental Scientist/Engineer, Huffman and Carpenter, LLC, 2007-2008; Senior Project Manager, Manhard Consulting, 2008-2013; Visiting Faculty, Humboldt State University, 2013-present; Senior Project Manager, Kimley-Horn and Associates, Inc., 2013-present.

Supervisor / Chair, Dissertation, "Habitat modeling of river ecosystems: multidimensional spatially explicit and dynamic habitat templates at scales relevant to fish", Status: Completed. (2006). Civil and Environmental Engineering, Utah State University.
Student(s): Craig Addley.

Additional Comments: Senior Consultant, Cardno Entrix, Inc., 2006-present.

Supervisor / Chair, Dissertation, "Development of an instream flow-based extrapolation procedure for the Nooksack Watershed", Status: Completed. (2006). Civil and Environmental Engineering, Utah State University.
Student(s): Ekaterina Saraeva.

Additional Comments: Post Doctoral Research Associate, Utah Water Research Laboratory, Utah State University, 2006-2011. Research Engineer, Watershed Systems Group, Inc. 2013-present.

Member, Master's Thesis, "Use of Bayesian belief network to quantify the uncertainty in estimates of salt loading from an irrigated watershed", Status: Completed. (2006). Utah State University.
Student(s): Lizzette Oman.

Member, Master's Thesis, "A simplified method for estimating sediment transport flow regimes based on a stream classification system", Status: Completed. (2005). Civil and Environmental Engineering, Utah State University.
Student(s): Britanie Ames.

Supervisor / Chair, Master's Thesis, "A behavioral-based, mechanistic population model for sympatric stream salmonids using the SWARM simulation system", Status: Completed. (2005). Civil and Environmental Engineering, Utah State University.
Student(s): Eric McKlesky.

Supervisor / Chair, Master's Thesis, "Estimating uncertainty in fish habitat modeling using two-dimensional hydraulics", Status: Completed. (2004). Civil and Environmental Engineering, Utah State University.
Student(s): Mikhail Bhosle.

Member, Dissertation, "Water Management: Partnerships for Future Directions (Research and Testing Education Support Outreach)", Status: Completed. (2003). Utah State University.

Student(s): Bethany Neilson.

Member, Master's Thesis, "A comparative evaluation of instream flow protection criteria for aquatic resources on Forest Service managed stream systems", Status: Completed. (2003). Civil and Environmental Engineering, Utah State University.
Student(s): Hans Milliken.

Supervisor / Chair, Master's Thesis, "A methodology for assessing aquatic habitat and riparian habitat quality at the watershed scale", Status: Completed. (2003). Civil and Environmental Engineering, Utah State University.
Student(s): Jason Thompson.

Member, Dissertation, "Watershed -scale hydrology: Influences of spatial variability of snowpack in a semiarid, mountainous environment", Status: Completed. (2001). Utah State University.
Student(s): Rajiv Prasad.

Supervisor / Chair, Master's Thesis, "Development and testing of a rapid assessment methodology for instream habitat", Status: Completed. (2000). Civil and Environmental Engineering, Utah State University.
Student(s): Nathan Kennard.

Member, Dissertation, "Polder design for conjunctive flood-groundwater management", Status: Completed. (1999). Utah State University.
Student(s): Shyamal Bikash Chowdhury.

Supervisor / Chair, Master's Thesis, "Validation of an individual-based, mechanistic habitat selection model for drift-feeding salmonids", Status: Completed. (1999). Civil and Environmental Engineering, Utah State University.
Student(s): Greg Guensch.

Supervisor / Chair, Master's Thesis, "The application of multi-spectral airborne imagery for the detection of temporal changes in stream channel characteristics", Status: Completed. (1999). Civil and Environmental Engineering, Utah State University.
Student(s): Loni Johnson.

Supervisor / Chair, Master's Thesis, "Comparison of physical habitat simulation models with energetic modeling for habitat use", Status: Completed. (1997). Civil and Environmental Engineering, Utah State University.
Student(s): Jennifer Ludlow.

Supervisor / Chair, Master's Thesis, "Development and utilization of a physical habitat model for *Etheostoma fonticola* in the Landa Lake and Comal River systems", Status: Completed. (1997). Civil and Environmental Engineering, Utah State University.

Student(s): Nathan Bartsch.

Supervisor / Chair, Master's Thesis, "Evaluation of two-dimensional hydraulic modeling in a natural river and implications in instream flow assessment methods", Status: Completed. (1996). Civil and Environmental Engineering, Utah State University.
Student(s): Karl Tarbet.

Member, Dissertation, "Evaluation of pavement distress images using artificial neural networks", Status: Completed. (1995). Utah State University.
Student(s): Jacing Chou.

Supervisor / Chair, Master's Thesis, "Statistical modeling methodology for the determination of habitat suitability and habitat preferences of the endangered fountain darter", Status: Completed. (1995). Civil and Environmental Engineering, Utah State University.
Student(s): Michael Chulick.

Member, Master's Thesis, "Seasonal streamflow effects on salmonid habitat, and observations of fish movement in Beaver Creek, Idaho-Utah", Status: Completed. (1995). Utah State University.
Student(s): Shanda Fallau.

Member, Dissertation, "Command area decision support system for irrigation projects", Status: Completed. (1994). Utah State University.
Student(s): Somkiat Prajamwong.

Supervisor / Chair, Master's Thesis, "Delineation of mesoscale hydraulic features, subaqueous sediments, spawning sites, and riverine bathymetry in the south fork of the Salmon River utilizing multispectral, airborne videography", Status: Completed. (1994). Civil and Environmental Engineering, Utah State University.
Student(s): Brent Crowther.

Supervisor / Chair, Master's Thesis, "Use of multispectral aerial videography for jurisdictional delineation of wetland areas", Status: Completed. (1994). Civil and Environmental Engineering, Utah State University.
Student(s): James Shoemaker.

Supervisor / Chair, Master's Thesis, "Classification of mesoscale hydraulic features based on spectral analysis of multispectral aerial videography", Status: Completed. (1994). Civil and Environmental Engineering, Utah State University.
Student(s): Kiran Panja.

Supervisor / Chair, Master's Thesis, "Use of airborne multispectral videography for the classification and delineation of riparian vegetation", Status: Completed. (1994). Civil and Environmental Engineering, Utah State University.
Student(s): Thomas Redd.

Supervisor / Chair, Master's Thesis, "A mechanistic approach to modeling habitat needs of drift feeding salmonids", Status: Completed. (1991). Civil and Environmental Engineering, Utah State University.
Student(s): Craig Addley.

Supervisor / Chair, Master's Thesis, "Sources of uncertainty and effects on interpretation of results in the development of instream flows for fisheries habitat", Status: Completed. (1990). Civil and Environmental Engineering, Utah State University.
Student(s): Brent Bartz.

D. Courses Prepared and Curriculum Development:

BIOL 7360 – Approaches to Aquatic Resource Modeling, Curriculum Development: 1925.

CEE 103 – Digital computer applications in engineering, Curriculum Development: 1925.

CEE 363 – Introduction to Environmental Engineering, Curriculum Development: 1925.

CEE 369 – Environmental Systems Engineering, Curriculum Development: 1925.

CEE 493/693 Special problems in natural systems engineering, Curriculum Development: 1925.

CEE 5690/6690 – Natural Systems Engineering, Curriculum Development: 1925.

CEE 5700/6700 – Field sampling techniques, Curriculum Development: 1925.

CEE 5720/6720 – Natural Systems Modeling, Curriculum Development: 1925.

CEE 596/696 – Management of Regulated Rivers, Curriculum Development: 1925.

CEE 693 – Ecology and management of regulated rivers, Curriculum Development: 1925.

IF310 – Using the computer based PHABSIM system, Curriculum Development: 1925.

III. SCHOLARLY/CREATIVE

A. Works in Print (including works accepted, forthcoming, in press):

1. Books:

b. Textbooks:

Non-refereed:

Hardy, T. (2006). *The Theory and Application of the Physical Habitat Simulation System (PHABSIM)* (p. 148).
 Additional Comments: Translated into Japanese 2009
 Translated into Korean 2006

c. Edited Books:

Refereed:

Hardy, T., & Davis, N. (2017). *Texas Riparian Areas*. College Station, Texas, United States: Texas A&M University Press.

d. Chapters in Books:

Refereed:

Robertson, S., Wolaver, B., Birdsong, T., Smith, R., Hardy, T., Lewey, J., & Joplin, J. (Accepted / In Press). Developing the Science and Public Support Needed to Preserve the Devils River: A Case Study in Collaborative Conservation. In *Multispecies and Watershed Approaches to Freshwater Fish Conservation*.

Hardy, T., & Shaw, T. A. (2013). Application of real-time management for environmental flow regimes. In I. Maddock, A. Harby, P. Kemp, & P. Woods (Eds.), *Ecohydraulics: An Integrated Approach*. Chichester, UK: John Wiley & Sons. <https://doi.org/10.1002/9781118526576>

Hardy, T., Bowles, D. S., & Bosworth, K. (1987). Recursive river water quality estimation using abstract evolution equations in functional Sobolev spaces. In M. B. Beck (Ed.), *Systems analysis in water quality management* (pp. 321–331). London: Pergamon Press. <https://doi.org/10.1002/9781118526576>

Hardy, T., & Deacon, J. E. (1984). Streamflow requirements of roundtail darters (*Platypharodon argenteus*): Cyprinidae in the Virgin River, Utah, Arizona, Nevada. In N. V. Horner (Ed.), *Festschrift for Walter W. Dalquest in Honor of His Sixty-sixth Birthday* (pp. 141–163).

Hardy, T., Prewitt, C. G., & Voos, K. A. (1982). Application of a physical habitat usability model to the fish community in a spring-fed desert

stream. In Lauenroth, Skogerboe, & Flug (Eds.), *Analysis of Ecological Systems: State-of-the-Art in Ecological Modeling* (pp. 391–397). Elsevier Scientific Publishing Company.

e. Creative Books:

Hardy, T. (2003). *Arielle's Answer*.

2. Articles:

a. Refereed Journal Articles:

Trombley, C., Hardy, T., & Schwalb, A. (Accepted / In Press). Changes in fish assemblage after disturbance event caused by sudden increase in salinity in a perennial desert stream. *Environmental Biology of Fishes*.

Birdsong, T. W., Bean, M., Grabowski, T. B., Hardy, T., Heard, T., Holdstock, D., ... Tolman, K. (2015). Unmanned Aerial Systems in Aquatic Resources Management. *Journal of the Southeastern Association of Fish and Wildlife Agencies*. Accepted / In Press.

Crawford, M. A., Williamson, P. S., Cade, T. M., Lemke, D. E., & Hardy, T. (2020). Effects of photosynthetically active radiation on vegetative growth of Texas wild rice and consequences for population augmentation. *HortScience*, 55(7), 1000–1004.

Crawford, M. L., Williamson, P. S., Waliczek, T. M., Lemke, D. E., & Hardy, T. B. (2020). Effects of Photosynthetically Active Radiation on Vegetative Growth of Texas Wild Rice and Consequences for Population Augmentation. *HortScience*, 55(7), 1000–1004. Retrieved from <https://journals.ashs.org/hortsci/view/journals/hortsci/55/7/article-p1000.xml>
HORTSCIENCE 55-1.docx

Barr, J. R., Green, M. C., DeMasso, S. J., & Hardy, T. (2020). Drone Suveys Do Not Increase Colony-wide Flight Behaviour at Waterbird Nesting Sites, But Sensitivity Varies Among Species. *Scientific Reports*, 10. Published. <https://doi.org/10.1038/s41598-020-60543-z>

Seagroves, A., Barnhart, C., Hardy, T., & Schwalb, A. N. (2019). Reproductive ecology of the threatened and endemic freshwater mussel *Lampsilis bracteata*. *Aquatic Conserv: Mar Freshw Ecosyst.*, 1–11. <https://doi.org/DOI:10.1002/aqc.3154>

Seagroves, L. A., Barnhart, C., Hardy, T., & Schwalb, A. N. (2018). Reproductive ecology of the threatened and endemic freshwater mussel *Lampsilis bracteata*. *Aquatic Conservation*, 1 – 11. <https://doi.org/DOI:10.1002/aqc.3154>

- Barr, J. R., Green, M. C., DeMaso, S. J., & Hardy, T. B. (2018). Detectability and visibility biases associated with using a consumer-grade unmanned aircraft to survey nesting colonial waterbirds. *J. Field Ornithol.*, 89(3), 242–257. <https://doi.org/10.1111/jfo.12258>
- Gates, A. Y., Guerra, T. M., Morrison, F. B., Forstner, M. R., Hardy, T., & Hahn, D. (2018). Detection of Salmonella in the intestine of *Hypostomus plecostomus* from the upper San Marcos River, Texas. *Journal of Water and Health*, 16, 460–471. <https://doi.org/10.2166/wh.2018.235>
- Trombley, C. A., Hardy, T., & Schwalb, A. N. (2018). Disturbance-driven changes in fish assemblages caused by a sudden increase in salinity in a perennial desert stream. *Environmental Biology of Fishes*, 101, 791–798. <https://doi.org/https://doi.org/10.1007/s10641-018-0738-y>
- Hardy, T. B., Wright, K. A., Goodman, D. H., Som, N. A., Alvarez, J. J., & Martin, A. (2016). Improving hydrodynamic modelling: An analytical framework for assessment of two-dimensional hydrodynamic models. *River Research and Applications*. Published. <https://doi.org/DOI: 10.1002/rra.3067>
- Hardy, T., Kollaus, K., Tolman, K., Heard, T., & Howard, M. (2015). Ecohydraulics in applied river restoration: a case study in the San Marcos River, Texas, USA. *Journal of Applied Water Engineering and Research*. Published. Retrieved from <http://dx.doi.org/10.1080/23249676.2015.1090352>
- Som, N. A., Goodman, D. H., Perry, R. W., & Hardy, T. (2015). Habitat suitability criteria via parametric distributions: Estimation, model selection, and uncertainty. *River Research and Applications*. Published. Retrieved from <http://dx.doi.org/10.1080/23249676.2015.1090352>
- Kollaus, K. A., K. Behen, K. P., Heard, T., Hardy, T., & Bonner, T. H. (2014). Influence of urbanization on a karst terrain stream and fish community. *Urban Ecosystems*. Published. <https://doi.org/10.1007/s11252-014-0384-x>
- Basdekas, L., Bastidas, L. A., Hardy, T., Caplan, A. J., & McKee, M. (2012). Virgin River multi-objective optimization: Maximizing endangered fish habitat and minimizing costs. *International Journal of River Basin Management*, 12(1), 15–28.
- Perkin, J. S., Shattuck, Z. R., Bean, P. T., Bonner, T. H., Saraeva, E., & Hardy, T. (2010). Movement and microhabitat associations of Guadalupe Bass in two Texas rivers. *North American Journal of Fisheries Management*, 30, 33–46.
- Guzha, A. C., & Hardy, T. (2009). Application of the distributed hydrological model, TOPNET, to the Big Darby Creek watershed, Ohio, USA. *Water*

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- Saraeva, E., & Hardy, T. (2009). Prediction of fisheries physical habitat values based on hydraulic geometry and frequency distributions of depth and velocity. *International Journal of River Basin Management*, 7, 31–41.
- Hardy, T., Shaw, T., Addley, R. C., Smith, G. E., Rode, M., & Belchik, M. (2006). Validation of chinook fry behavior based escape cover modeling in the lower Klamath River. *International Journal of River Basin Management*, 4, 169–178.
- Hardy, T., & Addley, C. (2003). Instream flow assessment modeling: combining physical and behavioral-based approaches. *Canadian Water Resources Journal*, 28, 1–10.
- Gregory, P. J., I. Ingram, J. S., Anderson, R., Betts, R. A., Brovkin, V., Chase, T. N., ... Wilinon, M. J. (2002). Environmental consequences of alternative practices for intensifying crop production. *Agriculture, Ecosystem and Environment*, 88, 279–290.
- Guensch, G. R., Hardy, T., & Addley, R. C. (2001). Validation of an individual-based, mechanistic habitat selection model for drift-feeding salmonids. *Canadian Journal of Fisheries and Aquatic Science*, 58, 446–457.
- Goodwin, P., & Hardy, T. (1999). Integrated simulation of physical, chemical and ecological processes for river management. *Journal of Hydroinformatics*, 1, 33–58.
- Gilver, D. J., Bryant, R., & Hardy, T. (1999). Remote sensing of channel morphology and in-stream fluvial processes. *Progress in Environmental Science*, 1, 257–284.
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- Hardy, T. (1995). Assessing environmental effects of severe sustained drought. *Water Resources Bulletin*, 867–875.
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Bishop, A. B., Hardy, T., & Glabou, B. D. (1990). Analyzing instream flow tradeoffs for small hydropower development. *Rivers, 1*, 173–182.

Valdez, R., Holden, P., & Hardy, T. (1990). Habitat suitability index curves for humpback chub in the upper Colorado River Basin. *Rivers, 1*, 31–42.

b. Non-refereed Articles:

Trombley, C. A., Schwalb, A. N., Hardy, T., & Cottenie, K. (2021). Spatio-temporal analyses show conflicting evidence of the role of an invasive minnow in the decline of an endangered desert fish endemic to the south-western U.S.A. *Freshwater Biology*. Published. [https://doi.org/DOI: 10.1111/fwb.13823](https://doi.org/DOI:10.1111/fwb.13823)

Hardy, T. (2005). Klamath basin water resources issues: perspectives from the center of the event horizon. *The Water Report, 11*, 9–12, 16–17.

3. Conference Proceedings:

a. Refereed Conference Proceedings:

Kollaus, K., Heard, T., Williams, R., & Hardy, T. (2018). Application of an unmanned autonomous system for the quantitative assessment of aquatic vegetation restoration in the San Marcos River, Texas, USA.

Raphelt, N., Mayes, K., & Hardy, T. (2018). Integrating geomorphic assessments in ecological flow regimes: Case study in the San Antonio River, Texas, USA.

Hardy, T., Goodman, D. H., Perry, R. W., & Som, N. A. (2018). Mesohabitat delineations based on hydraulic geometry properties derived from the continuity equations.

Kollaus, K. A., Tolman, K. M., Heard, T. C., Raphelt, N., & Hardy, T. (2014). Assessing potential removal of two low-head dams in an urbanized Texas karst stream.

Hardy, T., Kollaus, K., Tolman, K., Heard, T., & Howard, M. (2014). Ecohydraulics in applied river restoration: A case study in the San Marcos River, Texas, USA.

Tolman, K. M., Kollaus, K. A., Heard, T. C., Hardy, T., Jensen, J., & Currit, N. (2014). Habitat suitability modeling of endangered, *Zizania texana*, within a highly urbanized, artesian ecosystem in San Marcos, Texas.

Hardy, T., Perry, R., Williamson, S., & Shaw, T. (2012). Application of a salmonids life cycle model for evaluation of alternative flow regimes.

- Duel, H., Hardy, T., Mader, H., & Kraml, J. (2012). River ecosystem observatory network initiative. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T., Jensen, A. M., Clemens, S., McKee, M., Mader, H., & Kraml, J. (2010). Development and application of a low cost unmanned autonomous vehicle for multispectral imaging of riparian and stream habitats (pp. 1200–1204). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T., Nowlin, W., Schwartz, B., & Bonner, T. (2010). Implementation of the San Marcos river observing system: a spatially explicit delineation of a spring system based on physical, hydrologic, chemical, and biological monitoring (pp. 1714–1721). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T. (2008). River restoration: Integration of sediment and riparian modeling for assessment of long-term post restoration conditions for aquatic resources.
- Hardy, T., Addley, R. C., & C. Acreman, M. (2001). Vertical integration of spatial and hydraulic data for improved habitat modeling using geographic information systems. IAHS Publication 266.
- Shoemaker, J., Ludlow, J., & Hardy, T. (1999). A system for collection of high precision bathymetry (p. 7). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
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- Hardy, T., & Addley, R. C. (1999). Three dimensional physical and bioenergetics habitat in large river systems using state-of-the-art hydroacoustics, GPS, GIS, photogrammetry, and computational fluid dynamics (p. 7). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Guencsh, G., & Hardy, T. (1999). Validation of a mechanistic habitat selection model for drift feeding salmonids (p. 8). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Ludlow, J. A., & Hardy, T. (1996). Comparative evaluation of suitability curve based habitat modeling and a mechanistic based bioenergetic model using 2-dimensional hydraulic simulations in a natural river system (Vol. B, pp. B519–B530). Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T., Bartsch, N., & Gubala, C. P. (1996). Determining habitat criteria for the endangered fountain darter through aquatic mapping and hydrologic

modeling (Vol. B, pp. B251–B262). Retrieved from
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

Hardy, T. (1996). Evaluation of one-dimensional and two-dimensional hydraulic modeling in a natural river and implications in instream flow assessment methods (Vol. B, pp. B395–B406). Retrieved from
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

Hardy, T. (1996). Formation of the international aquatic modeling group (Vol. A, pp. A845–850). Retrieved from
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

Hardy, T. (1996). The future of habitat modeling (Vol. B, pp. B448–B463). Retrieved from
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

Hardy, T. (1985). A survey of graduate education in environmental engineering.

b. Non-refereed:

Crowther, B. E., Hardy, T., & U. Neale, C. M. (1995). Application of multispectral video for the classification of fisheries habitat components in Salmon river, Idaho (pp. 143–157).

Pania, K. V., Hardy, T., & U. Neale, C. M. (1995). Comparison of multispectral videography based classification of mesoscale habitats and ground based mapping under turbid riverine conditions (pp. 157–166).

Hardy, T., & Shoemaker, J. A. (1995). Use of multispectral videography for spatial extrapolation of fisheries habitat use in the Comal river (pp. 134–142).

Redd, T. H., & Hardy, T. (1993). Classification and delineation of riparian vegetation on two western river systems using airborne multispectral video imagery. In C. M. U. Neale (Ed.).

Pania, K. V., & Hardy, T. (1993). Comparison of meso-scale hydraulic features at different discharges in a turbid river system using multispectral videography. In C. M. U. Neale (Ed.).

4. Abstracts:

Hoeinghaus, D. J., Jensen, J., Pease, A., Buckmeier, D., Smith, N., Daugherty, D., ... Allen, Y. (2019). Flow-specific floodplain inundation modeling and Alligator Gar recruitment in the lower Trinity River. Published.

Reynolds, M. L., Williamson, P. S., & Hardy, T. (2018). Effects of ambient light on vegetative growth of Texas wild rice. Published.

- Meitzen, K. M., Jensen, J., & Hardy, T. (2017). Integrating habitat suitability modeling and environmental flows for the conservation of the flood-dependant gar (*Atractosteus spatula*). Published.
- Hardy, T., & Saraeva, E. (2009). A comparative evaluation of habitat mapping versus hydraulic based habitat modeling to assess river restoration actions. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T. (2009). Addressing repeatability, uncertainty, scalability and bias in habitat mapping based approached to instream flow assessments. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Hardy, T., Saraeva, E., & Jensen, L. (2009). Application of stochastic time series modeling for incorporation of increased variability of flow in the development of instream flow recommendations. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
- Perkin, J., Bonner, T., & Hardy, T. (2009). Moving beyond a flat river – multidimensional attributing of river characteristics for aquatic resource investigations. Published.
- Hardy, T., & Addley, R. C. (2007). Physical habitat and bioenergetic assessments of anadromous fish flow needs. An integrated application of the natural flow paradigm to recommending instream flows. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>
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Bhosle, M., & Hardy, T. (2004). Estimating uncertainty in fish habitat modeling using two-dimensional hydraulics. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

Hardy, T., & Addley, R. C. (2004). Incorporation of fish behavior in physical habitat models. Published.

Addley, R. C., & Hardy, T. (2002). A decade of 2-dimensional instream flow modeling experience: Part 1 - Benefits and pitfalls of data collection and hydrodynamic modeling. Published. Retrieved from <http://www.iahr.org/site/cms/contentviewarticle.asp?article=663>

5. Reports:

Perry, R. W., Plumb, J. M., Jones, E. C., Som, N. A., Hardy, T., & Hetrick, N. J. (2020). *Application of the Stream Salmonid Simulator (S3) to Klamath River Fall Chinook Salmon: Parameterization and Calibration*. USGS.

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USGS Open File Reports:

Perry, R., Jones, E., Plumb, J., Som, N., Hetrick, N., Hardy, T., ... De Juilio, K. (Accepted / In Press). *Application of the Stream Salmonid Simulator to Trinity River Chinook Salmon*. United States: U.S. Geological Survey.

Perry, R. W., Jones, E. C., Plumb, J. M., Som, N. A., Hetrick, N. J., Hardy, T., ... De Juilio, K. P. (2018). *Application of the Stream Salmonid Simulator (S3) to the Restoration Reach of the Trinity River, California - Parameterization and Calibration* (p. 65). <https://doi.org/doi.org/10.3133/ofr20181174>.

B. Works Not in Print:

1. Papers Presented at Professional Meetings:

Trombley, C. A. (Presenter), Hardy, T., Schwalb, A. N., Cottenie, K., Canadian Society of Ecology and Evolution, "Patterns in the fish meta-assemblage of the Virgin River," Guelf, Ontario, Canada. (July 2018).

Kollaus, K. (Presenter), Heard, T., Williams, R., Chavez, L., Symmank, M., Hardy, T., 54th Annual Meeting of the Texas Chapter of the Wildlife Society, "Analysis of Unmanned Aerial System Imagery to Map Emergent Aquatic Vegetation in a Constructed Wetland," Wildlife Society, Dallas, TX, United States. (February 2018).

Hoeinghaus, D. (Presenter), Jennsen, J., Pease, A., Buckmeier, D., Smith, N., Daugherty, D., Winemiller, K., Hardy, T., Allen, Y., Texas Chapter of the American Fisheries Society, "Flow-specific floodplain inundation modeling, availability of suitable spawning habitat and recruitment of Alligator Gar in the lower Trinity River," American Fisheries Society, Texas A&M University, College Station, TX, United States. (January 2018).

Kollaus, K. (Presenter), Howard, M., Hardy, T., Texas Aquatic Plant Management Society, "San Marcos River Habitat Conservation Plan: Putting river restoration into practice Part 2.," Texas Aquatic Plant Management Society, San Antonio, TX, United States. (November 27, 2017).

Robertson, S. (Presenter), Birdsong, T., Smith, R., Wolaver, B., Hardy, T., Lewey, J., American Fisheries Society 147th Annual Meeting, "A Multidisciplinary Approach to Developing the Science and Public Support Needed to Maintain Instream Flows in the Devils River Basin, Texas," American Fisheries Society, Tampa, FL, United States. (August 24, 2017).

Hoeinghaus, D. (Presenter), Jennsen, J., Hardy, T., Winemiller, K., Pease, A., Allen, Y., Texas Chapter AFS Annual Meeting, "Quantification of alligator gar recruitment dynamics using a river-stage specific floodplain inundation model," Texas Chapter of the American Fisheries Society, Corpus Christi, TX, United States. (January 19, 2017).

Tolman, K., Hardy, T., Texas Colonial Waterbird Society Symposium, "Application of high-resolution, low-cost, unmanned aerial vehicles (UAVs) for surveying Brown Pelican nesting sites at North Deer Island in Galveston Bay," Galveston, TX. (November 18, 2016).

Hardy, T. (CoAuthor), Meitzen, K. M. (CoAuthor/Presenter), Jensen, J. (CoAuthor), 112th Annual meeting of the American Association of Geographers (AAG), "Modeling floodplain inundation to evaluate Gar (Lepisosteiformes) habitat suitability in the lower Guadalupe River, USA," American Association of Geographers, San Francisco, San Francisco, CA, United States. (March 29, 2016).

- Jensen, J. L.R. (CoAuthor), Hardy, T. (Presenter CoAuthor), Meitzen, K. M. (CoAuthor), 11th ISE 2016, Melbourne, Australia, "APPLICATION OF AN UNMANNED AERIAL SYSTEM TO OBTAIN REMOTELY SENSED DATA TO DERIVE A HIGH RESOLUTION DIGITAL TERRAIN MODEL OF RIVER TOPOGRAPHY FOR USE IN FLOW DEPENDENT INUNDATION MODELING OF RIPARIAN VEGETATION AND GAR (LEPISOSTEIFORMES) HABITAT," International Association for Hydro-Environment Engineering and Research, Melbourne, Melbourne, Australia. (February 2016).
- Hardy, T. (CoAuthor/Presenter), Meitzen, K. M. (CoAuthor), Jensen, J. (CoAuthor), 11th ISE 2016, Melbourne, Australia, "DEVELOPMENT OF A FLOW DEPENDENT INUNDATION MODEL FOR EVALUATING GAR (LEPISOSTEIFORMES) HABITAT SUITABILITY IN THE LOWER GUADALUPE RIVER, USA," International Association for Hydro-Environment Engineering and Research, Melbourne, Melbourne, Australia. (February 2016).
- Hardy, T. (CoAuthor/Presenter), Perry, R. W. (CoAuthor), Plumb, J. M. (CoAuthor), Som, N. A. (CoAuthor), Hetrick, N. (CoAuthor), 11th ISE 2016, Melbourne, Australia, "MODELING FISH MOVEMENT IN A SPATIALLY EXPLICIT POPULATION MODEL OF JUVENILE CHINOOK SALMON IN THE KLAMATH RIVER, USA," International Association for Hydro-Environment Engineering and Research, Melbourne, Melbourne, Australia. (February 2016).
- Hardy, T. (CoAuthor/Presenter), Perry, R. W. (CoAuthor), Plumb, J. M. (CoAuthor), Som, N. A. (CoAuthor), Hetrick, N. (CoAuthor), 11th ISE 2016, Melbourne, Australia, "MODELING INFECTION AND MORTALITY IN A OF JUVENILE CHINOOK SALMON DUE TO DISEASE CAUSED BY CERATONOVA SHASTA IN THE KLAMATH RIVER," International Association for Hydro-Environment Engineering and Research, Melbourne, Melbourne, Australia. (February 2016).
- Hardy, T. B. (Presenter), Raphelt, N. (CoAuthor), 11th ISE 2016, Melbourne, Australia, "APPLICATION OF ADAPTIVE HYDRAULICS FOR ESTIMATION OF RIVER BED EVOLUTION AFTER DAM REMOVAL ON THE HABITAT QUANTITY AND QUALITY OF AQUATIC RESOURCES AND RIVER RECREATION," International Association for Hydro-Environment Engineering and Research, Melbourne, Australia. (February 7, 2016).
- Kollaus, K. A., Heard, T. C., Tolman, K. M., Birdsong, T., Hardy, T., Texas Chapter of the Wildlife Society, "Evaluation of a low-cost unmanned aerial system to support management and conservation efforts of Texas coastal resources," Corpus Christi, TX. (January 19, 2015).
- Villarreal, N., Symmank, M., Frisbie, M., Hardy, T., Tolman, K., Jensen, J., Texas Chapter of the Wildlife Society, "Surveying wetland vegetation with an unmanned aerial system," Corpus Christi, TX. (January 19, 2015).

- Hardy, T., Techniques and Technologies Workshop. 51st Annual Meeting of the Texas Chapter of the Wildfire Society, "Unmanned autonomous vehicles," Corpus Christi, TX. (January 19, 2015).
- Hardy, T., Texas Chapter of the American Fisheries Society, "Application of an unmanned aerial vehicle system supporting Guadalupe bass restoration during drought," Tyler, TX. (January 17, 2015).
- Clark, L., Tolman, K., Hardy, T., Texas Natural Resources Information System. 26th Annual GIS Forum, "UAV exotic vegetation classification and interactive web mapping." (October 24, 2014).
- Alvarez, J., Goodman, D., Martin, A., Hardy, T., 2013 Western Division Annual Meeting, American Fisheries Society, "Level of effort and prediction success: techniques for 2D hydrodynamic habitat modeling," Boise, ID. (April 18, 2013).
- Behen, K. P., Curtis, S. G., Kollaus, K. A., Hardy, T., Bonner, T. H., Texas Chapter American Fisheries Society, "Effects of recreational activities on the spatial and temporal trends in habitat associations for the fish assemblage of the San Marcos River," Galveston, TX. (2012).
- Kollaus, K., Behen, K. P., Heard, T. C., Tennant, J. M., Hardy, T., Bonner, T. H., Texas Chapter American Fisheries Society, "Influence of watershed and instream alterations on the upper San Marcos River fish assemblage," Galveston, TX. (2012).
- Tolman, K., Hardy, T., Kollaus, K., Heard, T., Tennant, J., TNRIS GIS Forum, "Use of small, autonomous unmanned aerial vehicles for capturing multispectral aerial imagery," Pickle Center, Austin, TX. (2012).
- Hardy, T., Kollaus, K., Heard, T., Tennant, J., 14th World Lake Conference, "Use of UAV for remote sensing of surface water systems," Austin, TX. (November 4, 2011).
- Kollaus, K. K., Hardy, T., Heard, T., Tennant, J., Jensen, A., American Fisheries Society 141st Annual Meeting, "Deployment and flight training procedures associated with using small, autonomous unmanned aerial vehicles for capturing multispectral aerial imagery," Seattle, WA. (September 8, 2011).
- Hardy, T., Nowlin, W. H., Schwartz, B., Bonner, T., American Fisheries Society 141st Annual Meeting, "San Marcos Observing System: integrating physical, chemical, and biological data at high resolution spatial and temporal scales," Seattle, WA. (September 8, 2011).
- Behen, K., Kollaus, K. K., Hardy, T., Bonner, T. H., American Fisheries Society 141st Annual Meeting, "Spatial and temporal trends in habitat associations of the fish community in Spring Lake and the headwaters of the San Marcos River," Seattle, WA. (September 8, 2011).
- Mock, L., Schwartz, B. F., Nowlin, W. H., Hutchins, B. T., Hardy, T., Bonner, T. H., Lockwood, A., Steinback, A., National Conference of Standards Laboratories

International Workshop and Symposium, "The role of metrology in monitoring and preserving the water quality in the Edwards Aquifer in Central Texas," Gaylord National Convention Center, National Harbor, MD. (August 25, 2011).

Tower, K., Hardy, T., Kollaus, K., Heard, T. C., Tennant, J. M., Southwestern Association of Naturalist 58th annual meeting, "Habitat characterization of *Zizania texana* within the San Marcos River," University of Texas, Tyler, TX. (April 22, 2011).

Tower, K., Hardy, T., Kollaus, K., Heard, T. C., Tennant, J. M., Texas Academy of Science, "Modeling the spatial relationship of riparian shade distribution as it relates to aquatic species distribution within the San Marcos River," St. Edwards University, Austin, TX. (March 4, 2011).

Bonner, T., Hardy, T., Mayes, K., Texas Chapter American Fisheries Society, "Calculating habitat suitability for Texas fishes from expert perception: a request for participation," San Marcos, TX. (February 12, 2011).

Mayes, K., Aziz, K., Botros, J., Robertson, C., Hardy, T., Littroll, B., Texas Chapter American Fisheries Society, "Using envelope curves to derive fish habitat suitability indices for instream flow assessments," San Marcos, TX. (February 12, 2011).

Williams, C. R., Hardy, T., Tower, K., Texas Aquatic Plant Management Society, "Spring Lake aquatic vegetation mapping project," Bandera, TX. (October 27, 2010).
Additional Comments: Student oral presentation 2nd place

Williams, C. R., Hardy, T., Steinback, A., Texas Aquatic Plant Management Society, "Distribution and habitat of *Hygrophila polysperma* along the San Marcos River," Bandera, TX. (October 25, 2010).
Additional Comments: Student poster 1st place

Hardy, T., McKee, M., 139th meeting of the American Fisheries Society, "Role of science and scientists in stakeholder driven instream flow assessments." (September 3, 2009).

Hardy, T., Saraeva, E., The 7th International Symposium on Ecohydraulics, "A comparative evaluation of habitat mapping versus hydraulic based habitat modeling to assess river restoration actions," Concepcion, Chile. (February 16, 2009).

Hardy, T., The 7th International Symposium on Ecohydraulics, "Addressing repeatability, uncertainty, scalability and bias in habitat mapping based approached to instream flow assessments," Concepcion, Chile. (February 16, 2009).

Hardy, T., Saraeva, E., Jensen, L., The 7th International Symposium on Ecohydraulics, "Application of stochastic time series modeling for incorporation of increased variability of flow in the development of instream flow recommendations," Concepcion, Chile. (February 16, 2009).

Perkin, J., Bonner, T., Hardy, T., The 7th International Symposium on Ecohydraulics, "Moving beyond a flat river – multidimensional attributing of river characteristics for aquatic resource investigations," Concepcion, Chile. (February 16, 2009).

Hardy, T., Addley, R. C., The 6th International Symposium on Ecohydraulics, "Physical habitat and bioenergetic assessments of anadromous fish flow needs. An integrated application of the natural flow paradigm to recommending instream flows," Christchurch, New Zealand. (February 27, 2007).

Basdekas, L., Hardy, T., Addley, R. C., Bradford, W., Hammond, J., Presented at the 5th International Symposium on Ecohydraulics, "Benefits evaluation of channel reconstruction on Lower LaVerkin Creek using two-dimensional hydrodynamics and biological habitat modeling," Madrid, Spain. (September 17, 2004).

Combs, M., Gowing, I., Hardy, T., Presented at the 5th International Symposium on Ecohydraulics, "Comparative evaluation of a rapid assessment methodology for instream flow assessments with intensive physical habitat simulation (PHABSIM) approaches," Madrid, Spain. (September 17, 2004).

Thompson, J., Hardy, T., Presented at the 5th International Symposium on Ecohydraulics, "Development and application of a GIS based river basin assessment tool for prioritization of aquatic habitat restoration at the watershed level," Madrid, Spain. (September 17, 2004).

Saraeva, E., Hardy, T., Presented at the 5th International Symposium on Ecohydraulics, "Development and application of GIS based instream flow extrapolation procedure for watershed planning in the Nooksack River basin," Madrid, Spain. (September 17, 2004).

Bhosle, M., Hardy, T., Presented at the 5th International Symposium on Ecohydraulics, "Estimating uncertainty in fish habitat modeling using two-dimensional hydraulics," Madrid, Spain. (September 17, 2004).

Hardy, T., Addley, R. C., Presented at the 5th International Symposium on Ecohydraulics, "Incorporation of fish behavior in physical habitat models," Madrid, Spain. (September 17, 2004).

Additional Comments: Presented as the keynote address

Basdekas, L., Bastidas, L., Caplan, A., Hardy, T., McKee, M., Stevens, D., UCOWR/NIWA Conference, "Balancing water use, water rights, endangered species, and economics: a multi-objective, system operations optimization approach," Portland, OR. (July 22, 2004).

Hardy, T., Lower Klamath Basin Science Conference, "Field validation of habitat modeling in the lower Klamath River," Redding, CA. (June 9, 2004).

Hardy, T., Lower Klamath Basin Science Conference, "Field validation of habitat modeling of Chinook spawning and fry life stages in the lower Klamath River," Redding, CA. (April 23, 2004).

Additional Comments: abstract #H52A-1157

Hardy, T., American Fisheries Society Conference, "An applied decision support system using multidisciplinary assessment methods for instream flows – Nooksack River basin," Austin, TX. (February 9, 2004).

Dodd, A. M., Cashman, E. M., Hardy, T., American Geophysical Union Fall Meeting, "One-Dimensional Sediment Transport and Turbulence," San Francisco, CA. (December 12, 2003).

Hardy, T., Institute for Natural Systems Engineering, "EDN 1: Hydraulic model calibration files and supporting analysis files. Prepared for The WRIA 1 Watershed Management Project," Utah Water Research Laboratory, Utah State University, Logan, UT. (2002).

Addley, R. C., Hardy, T., 4th International Symposium on Ecohydraulics, "A decade of 2-dimensional instream flow modeling experience: Part 1 - Benefits and pitfalls of data collection and hydrodynamic modeling," Cape Town, South Africa. (March 8, 2002).

Hardy, T., Addley, R. C., Annual Meeting of the Bonneville Chapter American Fisheries Society, "Vertical integration of spatial and hydraulic data for improved habitat modeling in GIS." (March 18, 1999).

Addley, R. C., Hardy, T., American Fisheries Society Annual Meeting, "Bioenergetics: a biological response base approach to instream flow assessments," Monterey, CA. (1997).

Hardy, T., Proceedings of the Annual Spring Symposium of the American Water Resources Association, Water in the 21st Century: Conservation, Demand, and Supply, "Water resource system operations and endangered species in the Virgin River Basin: past, present and future," Salt Lake City, UT. (April 26, 1995).

U. Neale, C. M., Hardy, T., Shomaker, J. A., Department of Civil and Environmental Engineering, "Evaluation of coastal wetland states using spatial and spectral metrics derived from multispectral videographic imagery," Utah State University, Logan, UT. (1994).

Additional Comments: Final Report to Environmental Protection Agency, Corvallis, Oregon

Hardy, T., Anderson, P., U. Neale, C. M., Stevens, D. K., Proceedings of the American Water Resources Association, on Effects on Human Induced Changes on Hydrologic Systems, "Application of multispectral videography for the delineation of riverine depths and mesoscale hydraulic features," Jackson Hole, WY. (June 29, 1994).

Hardy, T., American Water Resources Association, Effects on Human-Induced Changes on Hydrologic Systems, "Use of GIS in multidisciplinary studies for instream flow assessments of endangered species in the Comal River ecosystem," Jackson Hole, WY. (June 29, 1994).

Additional Comments: Paper and Presentation

Hardy, T., Utah Water Users Group Annual Meetings, "Issues on endangered species," St. George, UT. (April 17, 1994).

Additional Comments: Abstract and Presentation

Hardy, T., American Fisheries Society Winter Technical Meeting, Bonneville Chapter, "Application of multi-spectral videography for resource management in the Virgin River Basin," Wendover, NV. (November 14, 1993).

Additional Comments: Paper and Presentation

Hardy, T., Addley, R. C., American Fisheries Society Bonneville Chapter and Wildlife Society Utah Chapter Joint Winter Technical Session, "Distribution and abundance of Virgin Spinedace (*Lepidomeda mollispinis mollispinis*) in the Virgin River basin," St. George, UT. (February 26, 1993).

2. Invited Talks, Lectures, and Presentations:

Hardy, T., Texas State University Department of Geography Annual Colloquium, "An accidental Geographer - The Road Less Traveled," Department of Geography, Texas State University, San Marcos, TX, United States. (2018).

Hardy, T., Environmental Science and Engineering Graduate Seminar, "Applied Ecohydraulics: Where Ecology Meets Civil and Environmental Engineering," University of Texas at San Antonio, San Antonio, TX, United States. (2018).

Hardy, T., Mayes, K., Raphael, N., 13th Annual Continuing Education Workshop, "Integrating Geomorphic Assessments in Ecological Flow Regimes," Environmental and Water Resources Institute. ASCE, University of Texas, Austin. (June 2018).

Perry, R., Plumb, J., Jones, E., Som, N., Hetrick, N., Hardy, T., Department of Biology Seminar Series, "The Stream Salmonid Simulator (S3): a Decision Support Model for Assessing Effects of Water Management and Habitat Restoration on Juvenile Salmon Production," Texas State University, San Marcos, United States. (2017).

Hardy, T., Envision Austin, "The importance of the environment and ecosystems in the urban environment," Austin. (2015).

Hardy, T., Capital Area Erosion Control Network (CAECN), "Case Studies and Investigations – Meadows Foundation." (November 12, 2015).

Hardy, T., Instream Flow Council, "Protecting Rivers and Lakes in the face of Uncertainty," Portland, OR. (April 30, 2015).

Hardy, T., Texas Commission on Environmental Quality (TCEQ) – Surface Water Quality Monitoring Workshop, "Status of aquatic habitat in Texas," Bandera, TX. (October 28, 2014).

Hardy, T., Regional Livability Symposium - Water: Key to Our Future, "Environmental economics," University of Texas Union. (February 15, 2013).

Hardy, T., Texas Commission on Environmental Quality, "The ESP of instream flows." (November 13, 2008).

Hardy, T., Texas Commission on Environmental Quality, "The ESP of instream flows." (November 13, 2008).

Hardy, T., International Symposium on the Stream Corridor Restoration, "River restoration: Integration of sediment and riparian modeling for assessment of long-term post restoration conditions for aquatic resources," River Environmental Technology Institute, Seoul, North Korea. (November 11, 2008).

Hardy, T., Instream Flow Council 2008 Conference, "Instream flow council science panel." (October 2008).

Hardy, T., 4th International Workshop on River Environment - Prospects for the River Restoration Technique Harmonizing with Flood Control and River Environment, "Applied river restoration under high flow constraints – A case study of design and implementation of fish habitat, sediment augmentation, and channel maintenance/riparian flow regimes in the Trinity River, California, USA," Seoul, North Korea. (June 4, 2008).

Additional Comments: Proceedings papers printed in English and Korean

Hardy, T., River Systems Institute, "The role of decision support systems in strategic watershed planning: practice to pitfalls," Texas State University. (May 2008).

Hardy, T., Texas Geographic Information Committee, "The use of aerial drone technology to collect remote sensing data for GIS applications." (January 2008).

Hardy, T., Texas Geographic Information Council Quarterly Meeting, "The use of aerial drone technology to collect remote sensing data for GIS applications," Austin, TX. (January 30, 2008).

Hardy, T., 2008 Texas Chapter of the American Fisheries Society meeting, "Modeling game and non-game species – assessing flow dependent needs," Texas Tech University. (January 19, 2008).

Hardy, T., Texas Chapter of the American Fisheries Society, "Application of physical habitat modeling for game and non-games fish interactions." (January 8, 2008).

Chen, Y., Hardy, T., McKee, M., International Symposium on the Stream Corridor Restoration, "Unmanned autonomous vehicles: Emerging cost effective technologies for fisheries research and management," Texas Chapter American Fisheries Society. (January 8, 2008).

- Hardy, T., Addley, R. C., 6th International Symposium on Ecohydraulics, "Physical habitat and bioenergetic assessments of anadromous fish flow needs. An integrated application of the natural flow paradigm to recommending instream flows," Christchurch, New Zealand. (2007).
- Hardy, T., American Fisheries Society annual meeting, "Conceptual validation of flow recommendations for salmon in the Klamath Basin using independent models," San Francisco, CA. (September 2007).
- Acreman, M. C., Booker, D. J., Dunbar, M. J., Goodwin, T., Young, A. R., Gowing, I. M., Rivas-Casado, M., Maddock, I., Hill, G., Hardy, T., Allan, S., Texas Geographic Information Council Quarterly Meeting, "A risk-based approach to rapid assessment of physical habitat sensitivity to abstraction," TISOR International Conference on "Riverine Hydroecology: advances in research and applications", Sterling University, United Kingdom. (2006).
- Hardy, T., LCRA/SAWS Science Symposium, "Incorporating ecological risk in assessing instream flows," Austin, TX. (March 2006).
- Hardy, T., Institut National Recherche Scientifique - Eau, Terre et Environnement/ Université Laval, "Modeling impact assessments in fluvial systems – A virtual river view," Geosalar Conference, Geomatics and Fish Habitat Modeling in Rivers and Estuaries, Quebec City. (November 18, 2005).
- Hardy, T., GIS in Water Resources course taught concurrently at University of Texas at Austin and USU (CEE 6440), "Use of GIS to integrate spatial data in instream flow assessments." (November 15, 2005).
- Hardy, T., Flows for the Future, 2005 Environmental Flows Conferences, "The science of instream flows – Evidence of an adaptive process and the dichotomy of perceived information needs," River Systems Institute, Texas State University, San Marcos, TX. (November 1, 2005).
- Hardy, T., Water in the West: Use-Abuse-and Scarcity, "Managing water for endangered fishes," An NR Week Symposium of the College of Natural Resources and the USU Water Initiative, Utah State University, Logan, UT. (October 2005).
- Hardy, T., Stevens, D. K., GSA Annual Meeting and Exposition, "Linking operational hydrology and water quality modeling in the Weber basin: A decision support system," Salt Lake City, UT. (October 16, 2005).
- Hardy, T., Lower Klamath Basin Science, "Field validation of habitat modeling in the lower Klamath River," Redding, CA. (June 9, 2004).
- Hardy, T., Lower Klamath Basin Science Conference, "The use of hydrologic modeling in the development of flow recommendations," Redding, CA. (June 9, 2004).

- Hardy, T., American Fisheries Society Conference, "An applied decision support system using multidisciplinary assessment methods for instream flows – Nooksack River Basin," Austin, TX. (February 11, 2004).
- Bishop, B., Hardy, T., McKee, M., Northern Utah Conference on Evidence, Eccles Conference Center, Utah State University, Logan, UT. (October 10, 2003).
- Hardy, T., Inland Northwest Research Alliance 2003 Subsurface Science Symposium, "Role of Stakeholders in Determining Environmental Policy," Salt Lake City, CA. (October 6, 2003).
- Hardy, T., Addley, C., American Fisheries Society 133rd Annual Meeting, "Instream flow assessment modeling: combining physical and behavioral-based approaches," Quebec City. (August 12, 2003).
- Hardy, T., Western Division of the American Fisheries Society Annual Meeting, "Technical assessment of instream flows in the lower Klamath River," San Diego, CA. (April 15, 2003).
- Hardy, T., 14th Annual International HydroVision Conference, "The state-of-the-art in habitat modeling," Seattle, WA. (August 1, 2002).
- Hardy, T., Fourth International Ecohydraulics Conference, "A decade of 2-dimensional instream flow modeling experience benefits and pitfalls of 2-dimensional habitat modeling," Cape Town, South Africa. (March 2002).
- Hardy, T., Guensch, G., Hydro-ecology Session at IAHS Annual Meeting, "Field validation of a mechanistic based bioenergetic model for drift feeding salmonids," Birmingham, United Kingdom. (July 1999).
- Hardy, T., Addley, R. C., Hydro-ecology Session at IAHS Annual Meeting, "Vertical integration of spatial and hydraulic data for improved habitat modeling in GIS," Birmingham, United Kingdom. (July 1999).
- Hardy, T., Addley, R. C., Hydro-ecology Session at IAHS Annual Meeting, "Vertical integration of spatial and hydraulic data for improved habitat modeling in GIS," Birmingham, United Kingdom. (July 1999).
- Hardy, T., Waite, P., Geuntsch, G., International Symposium for Ecology, "Evaluation of a mechanistically based salmonid model for stream position choice," INTECOL 1998, Florence, Italy. (1998).
- Hardy, T., International Symposium for Ecology, "Linkages between spatial sampling strategies, habitat heterogeneity and hydraulic modeling with implications to applied instream flow assessments," INTECOL 1998, Florence, Italy. (1998).
- Hardy, T., Addley, R. C., Trout Population Dynamics at Stream Reach and Stream Network Scales: Quantifying Physical and Biological Processes, "Physical data

necessary to describe trout populations at the stream reach and larger scale," Fort Collins, CO. (April 1998).

Hardy, T., 17th International Symposium of the North American Lake Management Society, "Moving toward trophic-level-based, ecologically-based instream flow regimes," Instream and Environmental Flows Symposium Technology and Policy Issues, Houston, TX. (December 2, 1997).

Hardy, T., Fourth Annual Water Summit, "Understanding the biology of your watershed," Utah Water Users Association, Salt Lake City. (November 1997).

Shoemaker, J., Dey, P., Hardy, T., Panja, K., Annual ERDAS Users Group Meeting, "Application of multispectral videography for natural resource classifications." (1996).

Hardy, T., Bartsch, N., Connor, P., American Water Resources Association Annual Water Resources Conference, "Habitat and flow requirements – instream flow methodology, monitoring, and the best guess," Watershed Management to Protect Declining Species and Symposium on Water Resources and World Wide Web, Seattle, WA. (December 9, 1996).

Hardy, T., Winter Meeting of the Bonneville Chapter of the American Fisheries Society, "Integration of Low Cost GPS with GIS for Fisheries Resource Management," Logan, UT. (February 29, 1996).

Gubala, C. P., Hardy, T., Eilers, J., Trimble Surveying and Mapping Users Conference and Exposition, "SONAR-GPS mapping of aquatic ecosystems and GPS assisted survey of small rivers, streams and creeks," Houston, TX. (August 11, 1995).

Hardy, T., 29th Annual Conference and Symposium "Effluent Use Management" American Water Resources Association, "Environmental impacts of severe sustained drought: case studies," Tucson, AZ. (September 2, 1993).

Anderson, P. C., Hardy, T., U. Neale, C. M., 14th Biennial Workshop on Color Photography and Videography for Resource Monitoring, "Application of multispectral videography for the delineation of riverine depths and mesoscale hydraulic features," Utah State University, Logan, UT. (May 28, 1993).

Shoemaker, J., U. Neale, C. M., Dobrowolski, J. P., Hardy, T., 14th Biennial Workshop on Color Photography and Videography for Resource Monitoring, "Use of multispectral videography for jurisdictional delineation of wetland areas," Utah State University, Logan, UT. (May 25, 1993).

Hardy, T., Panja, K. V., Anderson, P. C., American Fisheries Society Bonneville Chapter and Wildlife Society Utah Chapter Joint Winter Technical Session, "Application of multi-spectral videography for resource management in the Virgin River basin," St. George, UT. (February 26, 1993).

Dupont, R. R., Hardy, T., 81st Annual Conference of the Air Pollution Control Federation, "Estimating the uncertainty of hazardous air emissions from land treatment systems using the Thibodeaux-Hwang air emission model," Dallas, TX. (June 24, 1988).

Hardy, T., Bowles, D. S., Finney, B. A., American Geophysical Union Fall Annual Meeting, "A case for real time water quality management in the United States," San Francisco, CA. (1986).

3. Consultancies:

Development of tribal instream flow water right claims on the Flathead Indian Reservation, Montana. - Confederated Salish and Kootenai Tribes. (1925).

Expert witness in behalf of her Majesty the Queen of England in the Axford Inquiry. - The Crown of England. (1925).

Lead expert witness for federal fish related water claims on Forest Service lands in the Snake River Basin Adjudication. - Department of Justice. (1925).

Member of science team for development and application of a Chinook Salmon full life cycle model to evaluate Klamath River Dams removals for the Secretarial Determination (Secretary of the Interior). - Department of Interior. (1925).

Mono Basin Hearings before the California Water Development Board, Los Angeles. (1925).

Technical facilitator for Alberta Environment with first nations and oil sands development companies for water withdraw from the Athabasca River. Provincial Government of Alberta, Canada. (1925).

Technical review of Forest Service claims for fisheries in the Upper Klamath River Basin, Oregon. - Department of Justice. (1925).

4. Workshops:

Hardy, T., Texas Parks and Wildlife Department, "Unmanned Autonomous Vehicle Workshop," Kerr Wildlife Management Area, TX. (April 2013).

Hardy, T., Texas Parks and Wildlife Department, "Unmanned Autonomous Vehicle Workshop," Kerr Wildlife Management Area, TX. (April 2011).

Hardy, T., 8th International Symposium on Ecohydraulics, "Masters Class - Instream Flow Assessment Techniques," Seoul, North Korea. (September 11, 2010).

Hardy, T., Buckly Valley Resource Center, "Application of physical habitat modeling for salmonid restoration," Smithers, Canada. (2009).

- Hardy, T., 7th International Symposium on Ecohydraulics, "Application of physical habitat and behavior based modeling in fish communities," Concepcion, Chile. (February 16, 2009).
- Hardy, T., National Ecology Research Center, "IF310 Using the computer based PHABSIM system," U.S. Fish and Wildlife Service. (2008).
- Hardy, T., "Instream Flows 101," Texas State University. (2008).
- Hardy, T., "Instream Flows – Integration and Interpretation of study results," Texas State University. (2008).
- Hardy, T., Southwest Florida Water Management District, "Two-dimensional hydraulic and habitat modeling." (2008).
- Hardy, T., "Physical Habitat Simulation," Yamaguchi University. (2006).
- Hardy, T., U.S. Forest Service, "Application of habitat based assessment of project impacts on fisheries." (2001).
- Hardy, T., Alberta Environment, "Application of habitat based assessment of project impacts on fisheries," Alberta, Canada. (1998).
- Hardy, T., Department of Fisheries and Wildlife, "Wildlife habitat and plant management," Utah State University. (1998).
- Hardy, T., International Workshop-Institute of Hydrology, "Advanced instream flow techniques," Center of Hydrology and Ecology, Wallingford, England. (1997).
- Hardy, T., Mexico Institute of Freshwater Ecology, "Advanced instream flow techniques for quantification of impacts in rivers," Chutepeck, Mexico. (1997).
- Hardy, T., "Advanced instream flow techniques," Vienna, Austria. (1996).
- Hardy, T., "Advanced instream flow techniques in ephemeral rivers," Lisbon, Portugal. (1996).
- Hardy, T., "Applications of advanced instream flow techniques for protection of aquatic resources," University of Portugal. (1996).
- Hardy, T., National Rivers Authority, "Applications of advanced instream flow techniques for protection of aquatic resources," United Kingdom. (1995).
- Hardy, T., Utah Water Research Laboratory, "Research Methods." (1995).
- Hardy, T., USAID, "Central Asian Republic Interactive Site Workshops on Water Management." (1994).
- Hardy, T., Bureau of Land Management, "Instream Flow Techniques." (1994).

Hardy, T., Alberta Fish and Wildlife Service, "Northern Rivers Basin Instream Flow Technical Workshop," Canada. (1994).

Hardy, T., Bureau of Land Management, "Threatened and Endangered Species Consultation and Management Short Course." (1994).

Hardy, T., U.S. Forest Service Technical Training, "Development of instream flows for fisheries." (1991).

Hardy, T., U.S. Forest Service Technical Training, "IFIM Field techniques." (1991).

Hardy, T., "Instream negotiation strategies," Utah State University. (1991).

Hardy, T., Utah Division of Water Resources Professional Development Series, "Development of instream flows for fisheries." (1989).

5. Other Works not in Print:

a. Works "submitted" or "under review":

Journal Articles:

Trombley, C. A., Schwalb, A. N., Hardy, T., & Cottenie, K. (Submitted / Under Review). Spatial-temporal analyses show conflicting evidence of the role of invasive red shiner in the decline of endangered woundfin in the Virgin River. *Freshwater Biology*. (2020)

Gates, A., Guerra, T., Morrison, F., Forstner, M., Hardy, T., & Hahn, D. (Submitted / Under Review). Detection of Salmonella in the intestine of *Hypostomus plecostomus* from the upper San Marcos River, Texas. *Journal of Water and Health*. (October 1, 2017)

c. Other Works Not in Print:

Keynote / Plenary Addresses:

Hardy, T., 10th International Symposium on Ecohydraulics 2014, "The evolution of ecohydraulics: The emergence of holistic systems in decision making from simple beginnings," Trondheim, Norway. (June 27, 2014).

Hardy, T., International Conference on Ecological Modeling, "Incorporating behavior and production estimates into instream flow assessments," Ube Yamaguchi, Japan. (September 1, 2007).

C. Scholarly / Creative Grants and Contracts:

1. Funded External Grants and Contracts:

Nowlin, Weston Hugh (Principal), Percent Contribution: 21%, Schwalb, Astrid Nadine, Percent Contribution: 21%, Schwartz, Benjamin F, Percent Contribution: 21%, Hardy, Thomas (Co-Principal), Percent Contribution: 11%. Quantifying drivers of native and non-native aquatic species abundance and distribution in drought- and flood-prone Texas basins, U.S. Army Corp of Engineers, Federal, \$2,253,674.16. (Funded: October 2020 - September 2021). Grant.

Hardy, Thomas (Co-Principal), Ahlman, Todd Michael (Principal). USACE Omaha Sikes Act Cooperative Agreement, US Army Corp of Engineers, Federal, \$45,000,000.00. (Funded: August 25, 2016 - August 25, 2021). Grant.

Additional Comments: Contract is not to exceed \$45,000,000 during the 5 year period.

Winemiller, Kirk (Principal), Percent Contribution: 100%, Hardy, Thomas (Co-Principal), Percent Contribution: 100%. Environmental Flow Regime Assessment and Development of a Monitoring Framework, Texas Water Development Board, State, \$235,000.00. (Funded: January 2019 - March 2021). Contract.

Hardy, Thomas (Principal), Winemiller, Kirk (Co-Principal), Buskey, Edward (Co-Principal), Guillen, George (Co-Principal), Trungale, Joe (Co-Principal), Opdyke, Dan (Co-Principal), Annear, Tom (Co-Principal), Locke, Allan (Co-Principal), Estes, Christopher (Co-Principal). Statewide Synthesis of Environmental Flow Studies (2014-2017), Texas Water Development Board, State, \$237,000.00. (Funded: January 2019 - March 2021). Contract.

Jensen, Jennifer (Principal), Hardy, Thomas (Co-Principal). Implementing a validation framework for Dunes Sagebrush Lizard habitat classification, United States Fish and Wildlife Service, Federal, \$21,354.91. (Funded: July 1, 2020 - January 1, 2021). Contract.

Hardy, Thomas (Principal), Percent Contribution: 100%. Edwards Aquifer Habitat Conservation Plan, Edwards Aquifer Authority and City of San Marcos, Other, \$224,105.00. (Funded: January 1, 2020 - December 31, 2020). Contract.

Hardy, Thomas (Principal), Percent Contribution: 100%. Nuisance Vegetation Control in Spring Lake, Edwards Aquifer Authority and City of San Marcos, Other, \$11,200.00. (Funded: January 1, 2020 - December 31, 2020). Contract.

Hardy, Thomas, Percent Contribution: 100%. Evaluation and Refinement of Flow Resistance Equations for use in the XStream Software System, U.S. Forest

Service, Federal, \$60,740.00. (Funded: June 1, 2021 - September 30, 2020). Grant.

Hardy, Thomas (Principal), Percent Contribution: 50%, Forstner, Michael R (Co-Principal), Percent Contribution: 50%. Dunes Sagebrush Lizard, Texas Comptroller, State, \$936,109.39. (Funded: November 11, 2016 - January 31, 2020). Grant.

Hardy, Thomas (Principal), Percent Contribution: 100%. Edwards Aquifer Habitat Conservation Plan, Edwards Aquifer Authority and City of San Marcos, Other, \$210,000.00. (Funded: January 1, 2019 - December 31, 2019). Contract.

Green, Michael Clay (Principal), Jensen, Jennifer (Co-Principal), Hardy, Thomas (Co-Principal). Outreach and end-user support to implement Shared Conservation Priority Access, US Fish and Wildlife Service, Federal, \$77,000.00. (Funded: 2019). Grant.

Schwartz, Benjamin F, Nowlin, Weston Hugh, Hardy, Thomas, Jeong, Jaekak (Co-Principal), Wolfe, June (Co-Principal). Sessom Creek Sediment Export Study, Edwards Aquifer Authority - Habitat Conservation Plan, State, \$156,306.00. (Submitted: October 2017, Funded: March 2018 - December 2019). Contract.

Hardy, Thomas. Texas Conservation Plan (TCP) specific to the Dunes Sagebrush Lizard (*Sceloporus arenicolus*) (DSL), Texas Comptroller Office, State, \$555,135.00. (Funded: December 15, 2017 - December 31, 2019). Sponsored Research.

Additional Comments: Increased funding for expansion of Scope activities

Hardy, Thomas (Principal), Percent Contribution: 100%. Edwards Aquifer Habitat Conservation Plan, City of San Marcos and Edwards Aquifer Habitat Conservation Plan, State, \$224,165.00. (Funded: January 1, 2018 - December 31, 2018). Contract.

Hardy, Thomas (Principal), Forstner, Michael R (Co-Principal), Jensen, Jennifer (Co-Principal). Evaluation of Texas Conservation Plan and Dunes Sagebrush Lizard, Texas Comptroller of Public Accounts, State, \$1,495,010.06. (Funded: November 10, 2016 - December 31, 2018). Contract.

Jensen, Jennifer (Co-Principal), Green, Michael Clay (Principal), Hardy, Thomas (Co-Principal). Developing a process and conservation application for Landscape Conservation Design for the Gulf Coast Prairie Landscape Conservation Cooperative., Gulf Coast Prairie Landscape Conservation

Cooperative, Private / Foundation / Corporate, \$200,000.00. (Funded: April 2017 - October 2018). Grant.

Hardy, Thomas, Schwalb, Rodriguez, Forstner. TxDOT Evaluating the Effectiveness of, \$243,317.00. (Funded: September 1, 2015 - September 30, 2018). Grant.

Hardy, Thomas (Principal). Hurlburt Natural Resource Support, Monitor Wetlands, US Army Corp of Engineers, Federal, \$82,987.00. (Funded: October 31, 2017 - July 1, 2018). Contract.

Hardy, Thomas. Edwards Aquifer Habitat Conservation Plan, City of San Marcos and Edwards Aquifer Habitat Conservation Plan, State, \$219,800.00. (Funded: January 1, 2017 - December 31, 2017). Contract.

Hardy, Thomas, Schwalb. CESU-COE Impacts of Navigation on, \$55,038.90. (Funded: November 1, 2015 - September 30, 2017). Grant.

Hardy, Thomas, Hoeinghaus. GCPLLC - Quantification of Alligator, \$331,180.00. (Funded: September 1, 2015 - September 30, 2017). Grant.

Hardy, Thomas. TPWD Assessment/Model Environment, \$83,838.00. (Funded: August 4, 2015 - June 30, 2017). Grant.

Hardy, Thomas. TPWD Lower Guadalupe Gar Modeling, \$104,206.00. (Funded: October 29, 2015 - March 31, 2017). Grant.

Hardy, Thomas (Principal), Nowlin, Weston Hugh (Co-Principal), Williamson, Paula S (Co-Principal). Effects of suspended sediments on Texas wild rice, other macrophytes, and macroinvertebrates, Edwards Aquifer Authority (Edwards Aquifer Habitat Conservation Plan), Federal, \$75,000.00. (Funded: 2015 - 2016). Grant.

Hardy, Thomas, Schwalb. TPWD Development of HSC for, \$26,000.00. (Funded: September 1, 2015 - September 30, 2016). Grant.

Hardy, Thomas, Green, Others. Evaluation of the use of unmanned, \$43,809.00. (Funded: July 1, 2015 - September 30, 2016). Grant.

Hardy, Thomas. UAV Based Remote Sensing - Year 2, TPWD, State, \$17,506.65. (Funded: September 1, 2015 - August 31, 2016). Grant.

Hardy, Thomas. TPWD Peer Review Instream Flows, \$10,000.00. (Funded: September 1, 2015 - March 31, 2016). Grant.

Hardy, Thomas. EAA Sediment Impacts on TX Wild Rice, \$75,000.00. (Funded: January 1, 2015 - December 31, 2015). Grant.

Hardy, Thomas. UHCL HCP Texas Wild Rice- Year 3, \$516,813.00. (Funded: January 1, 2015 - December 31, 2015). Grant.

Hardy, Thomas. TPWD UAV Based Remote Sensing, \$17,506.65. (Funded: September 1, 2014 - August 31, 2015). Grant.

Hardy, Thomas. CONFEDERATED SALISH, \$362,778.00. (Funded: March 13, 2014 - June 30, 2015). Grant.

Hardy, Thomas. UHCL HCP Texas Wild Rice- Year 2, \$446,150.00. (Funded: January 1, 2014 - December 31, 2014). Grant.

Hardy, Thomas, Sansom. COYPU Expansion of Whooping Crane, \$45,000.00. (Funded: October 2, 2013 - December 31, 2014). Grant.

Hardy, Thomas. LIVINGSTON LURES Behavioral, \$40,384.00. (Funded: March 20, 2014 - August 31, 2014). Grant.

Hardy, Thomas. City Of Victoria Conduct Phase II, \$73,603.00. (Funded: September 1, 2013 - August 31, 2014). Grant.

Hardy, Thomas. GLEASON San Marcos WQPP, \$25,862.00. (Funded: April 1, 2013 - December 31, 2013). Grant.

Hardy, Thomas. UHCL HCP Texas Wild Rice- Year 1, \$448,588.00. (Funded: March 5, 2013 - December 31, 2013). Grant.

Hardy, Thomas. CofNB Technical Assistance for Habitat, \$11,000.00. (Funded: May 1, 2013 - November 30, 2013). Grant.

Hardy, Thomas. TPWD Texas Instream Flow Program, \$189,998.00. (Funded: September 1, 2009 - August 31, 2013). Grant.

Hardy, Thomas. TxDOT Fountain Darter Mgmt Cape, \$43,203.00. (Funded: September 1, 2012 - February 28, 2013). Grant.

Hardy, Thomas. TPWD Texas Wild Rice, \$50,000.00. (Funded: October 16, 2012 - January 13, 2013). Grant.

Hardy, Thomas. GRTU Guadalupe River Habitat, \$10,000.00. (Funded: January 1, 2011 - December 31, 2012). Grant.

Hardy, Thomas. CofSM Hydro Simulation Water Model, \$10,000.00. (Funded: July 16, 2012 - September 30, 2012). Grant.

Hardy, Thomas. City of New Braunfels USU Hydro, \$25,341.00. (Funded: March 1, 2012 - September 30, 2012). Grant.

Hardy, Thomas. TWDB Evaluation of Riparian Process, \$38,500.00. (Funded: March 1, 2011 - September 30, 2012). Grant.

Hardy, Thomas. CofNB HCP Work Plan Development, \$54,302.00. (Funded: July 23, 2012 - August 31, 2012). Grant.

Hardy, Thomas. Sul Ross YR5-Hardy, \$41,485.00. (Funded: June 30, 2009 - August 31, 2012). Grant.

Hardy, Thomas. TWDB Channel Cross Section, \$36,500.00. (Funded: January 1, 2011 - July 31, 2012). Grant.

Hardy, Thomas. TWDB Robotic Aerial Videography, \$34,966.00. (Funded: January 1, 2011 - July 31, 2012). Grant.

Hardy, Thomas. City of New Braunfels Interlocal Agreement, \$5,625.00. (Funded: February 1, 2012 - April 30, 2012). Grant.

Hardy, Thomas. UT Subcontract Creation of Models, \$20,641.00. (Funded: September 1, 2011 - January 5, 2012). Grant.

Hardy, Thomas. CoVictoria Effects on Guadalupe River, \$62,976.00. (Funded: May 15, 2011 - December 31, 2011). Grant.

Hardy, Thomas. TPWD Application of UAV Tech, \$51,999.00. (Funded: April 26, 2011 - December 31, 2011). Grant.

Hardy, Thomas. TAES (EAA) Setup Run Model, \$40,070.00. (Funded: June 1, 2010 - September 30, 2011). Grant.

Hardy, Thomas. CoSM GPR to Map River Sediments, \$25,000.00. (Funded: April 12, 2011 - September 1, 2011). Grant.

Hardy, Thomas, Sansom (Co-Principal), Schwartz (Co-Principal). ARRA-River System's Monitoring Project, \$106,300.00. (Funded: October 1, 2009 - August 31, 2011). Grant.

Hardy, Thomas, Sansom (Co-Principal), Bonner. ARRA-River System's Monitoring Project, \$109,000.00. (Funded: October 1, 2009 - August 31, 2011). Grant.

Hardy, Thomas, Sansom (Co-Principal), Nowlin. ARRA-River System's Monitoring Project, \$185,745.00. (Funded: October 1, 2009 - August 31, 2011). Grant.

Hardy, Thomas, Sansom (Co-Principal). ARRA-River System's Monitoring Project, \$226,000.00. (Funded: October 1, 2009 - August 31, 2011). Grant.

Hardy, Thomas, Sansom (Co-Principal). ARRA-River System's Monitoring Project, \$372,955.00. (Funded: October 1, 2009 - August 31, 2011). Grant.

Hardy, Thomas. Facilitating Sustain Water-YR4-XIA, \$50,429.00. (Funded: July 15, 2008 - June 14, 2011). Grant.

Hardy, Thomas, Sansom. TWDB- Guadalupe Santonio/Mission, \$5,709.48. (Funded: October 1, 2010 - February 15, 2011). Grant.

Hardy, Thomas. TAES (EAA) Rsch Improv Instream, \$165,940.00. (Funded: November 1, 2009 - October 31, 2010). Grant.

Hardy, Thomas. EAA Recovery Implementation Plan, \$254,940.00. (Funded: August 1, 2008 - December 31, 2009). Grant.

2. Submitted, but not Funded, External Grants and Contracts:

Hardy, Thomas. USDA AFRI Water for Agriculture Challenge Area Proposal "Precision Remote Sensing and Advanced Modeling Approaches for Sustainable Crop Water and Fertilization Management. (Funded: 1925). Grant.

D. Scholarly / Creative Fellowships, Awards, Honors:

Award / Honor Recipient: College of Engineering Research Excellence, Utah State University.
February 25, 1994

Award / Honor Recipient: NATO Advanced Study Institute for the use of Expert Systems in Civil Engineering through a grant awarded by the National Science Foundation in Edinburgh, Scotland. 1989.
1986

IV. SERVICE

A. Institutional

1. University:

Chair, Spring Lake Environmental Committee. (2012 - Present).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2018 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2021).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2018 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2020).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2018 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2019).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2018 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2018).

University Mentor. (2018).

Additional Comments: Participated in the SURE mentoring program and directed a student. I also participated as a seminar speaker to Peer-to-Peer mentoring students.

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2017 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2016).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2016 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2015).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2015 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2014).

Organizer, Prepared the Texas State University Edwards Aquifer Habitat Conservation Plan 2014 Annual Report Chapter. (2013).

Organizer, Prepared the Edwards Aquifer Habitat Conservation Plan 2013 Technical Work Plans for Texas State University and the City of San Marcos collaboratively with Ms. Melani Howard of the City of San Marcos. (2012).

Member, Central Promotion and Tenure Review, Utah State University. (2009).

Member, College of Engineering – Promotion and Tenure Review Committee, Utah State University. (2004 - 2009).

Member, Presidents Task Force on a Campus Wide Water Program, Utah State University. (2001 - 2005).

Undergraduate Advisor, ASCE Student Chapter Faculty Advisor, Utah State University. (1990 - 1996).

Member, Natural Resource Policy Program Advisory Committee, Utah State University. (1995).

Member, President's Diversity Team, Utah State University. (1995).

2. College:

Member, Environmental Engineering Faculty Search. (2018 - Present).

Member, Structures Engineering Faculty Search. (2018 - Present).

3. Department/School:

Co-Chair, Vehicle Use Committee. (October 1, 2016 - Present).

Member, Department of Biology. Aquatic Ecologist Faculty Search Committee. Texas State University. (2013).

Member, College of Engineering – Promotion and Tenure Committee Chair, Utah State University. (2008 - 2009).

Member, College of Engineering Post-Tenure Review Committee, Utah State University. (2006 - 2009).

Member, Division of Environmental Engineering Curriculum Committee, Utah State University. (1998 - 2000).

Co-Chair, CEE Computer Committee, Utah State University. (1990 - 1999).

Chair, College of Engineering Computer Committee, Utah State University. (1996 - 1998).

Undergraduate Advisor, College of Engineering Outstanding Junior Committee, Utah State University. (1994 - 1995).

Graduate Advisor, ASCE Student Chapter Faculty Advisor, Utah State University. (1989 - 1995).

Member, EE/CEE Microcomputer Laboratory Steering Committee, Utah State University. (1989 - 1992).

B. Professional:

Editor, Korean Journal of Civil and Environmental Engineering. (2011 - Present).

Member, IAHR Ecohydraulics Committee. (January 1, 2006 - Present).

Reviewer / Referee, Norwegian Science Board of Strategic Research Proposals. (1990 - Present).

Reviewer / Referee, International Association for Hydro-Environment Engineering and Research. (1988 - Present).

American Fisheries Society - Certified Fisheries Scientist. (2021).

Member, American Society of Civil Engineers. (2021).

Member, International Association for Hydro-Environment Engineering and Research. (2021).

Member, International Association for Hydro-Environment Engineering and Research, Melbourne, Australia. (January 2015 - February 2021).

Officer, Ecohydraulics Committee International Association for Hydro-Environment Engineering and Research. (2010 - 2017).

Member, American Water Resources Association. (2009).

Reviewer / Referee, Virgin River Fishes Recovery Team, USFWS. (1991 - 2009).

Member, American Society of Photogrammetry and Remote Sensing. (2006).

D. Organization Memberships:

President for the International Association for Hydro-Environment Engineering and Research Ecohydraulics Committee (IAHR). (2012 - 2014).

Secretary for the International Association for Hydro-Environment Engineering and Research Ecohydraulics Committee (IAHR). (2010 - 2012).

Associate Director for the Utah Water Research Laboratory. (2002 - 2009).

Director of the Institute for Natural Systems Engineering, Utah State University. (1989 - 2009).

E. Service Honors and Awards:

Award / Honor Recipient: Honorary Fellow of the Ecohydraulics Committee, International Association for Hydro-Environment Engineering and Research.
2018

Award / Honor Recipient: Texas Environmental Excellence Award, Texas Commission on Environmental Quality.

May 1, 2012 - May 4, 2016

Additional Comments: "Along with interacting with our students, the greatest privilege of working at Texas State University is for the Meadows Center team to be stewards of the San Marcos Springs, a globally significant resource," said Andrew Sansom, executive director at The Meadows Center for Water and the Environment. "We are doubly privileged to partner with the City of San Marcos in protecting the resources of the springs and the headwaters of the San Marcos River. This work is led by Dr. Thom Hardy of Texas State and Melanie Howard of the City of San Marcos and we are very proud of them."

Award / Honor Recipient: Lifetime Achievement Award, Instream Flow Council.
2015

Award / Honor Recipient: 1st ever named Fellow of the Utah Water Research Laboratory.
2009