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Perspective

Filling the void: On the path to establishing a national center for ecologically sustainable water conservation and management

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Access to water is essential to all life, but it is equally essential for utilitarian purposes such as power generation, agriculture, manufacturing, and construction. Although its global supply was once considered limitless, today's demands for water have far exceeded its availability in many settings, especially in densely populated geographic regions, which are often located in arid and semiarid zones. In some of these areas, intricate and expensive water conveyance systems have been constructed to deliver water from wetter regions, which correspondingly has led to diminishment of their supply. With these increased demands comes an increased risk to degrade freshwater ecosystems worldwide, fostering intense competition between needs that are strictly anthropogenically focused and utilitarian-based versus those that meet basic needs of freshwater ecosystems. Defining defensible flow and water level regimes that promote healthy ecosystems (rivers, lakes, wetlands, estuaries) is vital for their conservation (protection, restoration, and enhancement) and management. Supporting this is the need for research, development, and training in the interdisciplinary science-based methods to derive these flows/water levels, coupled with effective laws, policies, and public involvement. In this article, we posit that the most effective means of achieving this (i.e., defensible flow and water level regimes) is through the establishment of a National Center for Ecologically Sustainable Water Conservation and Management (Center) that mirrors in some respects the former Cooperative Instream Flow Service Group (CIFSG) that functioned from 1976 to 2001. Our rationale and a selected pathway leading to the development of the Center is described.

WHAT IS AT RISK AND WHAT IS MISSING?

Prior to the 1970s, water supply management primarily focused on meeting domestic, agricultural, industrial, and power generation demands. Although the scientific community was aware of ecological impacts associated with hydrologic alterations as early as the 1800s, there were limited or no legal and general public considerations given to the negative effects on the ecological functions that are necessary to support these systems (Locke et al., 2008; Marsh, 1864/2021). The legal means for protecting these systems was likewise limited or nonexistent. Indeed, at least in the western states, water use was often defined by its "Duty," which according to The *Water Rights Handbook for Colorado Conservation Professionals* (Nichols et al., 2005) is "the amount of water that through careful management and use, *without wastage*, is reasonably required to be applied to a tract of land for a length of time that is adequate to produce the maximum amount of crops that are ordinarily grown there." In essence, preserving water within a river, lake, reservoir, or connected water was considered wasteful. The persistence of this view remains problematic and is counter to the contemporaneous Brisbane Declaration (2007 , p. 1; conservationgateway.org), which states, "Environmental Flows are essential for freshwater ecosystem health and human well-being" and also:

> Healthy freshwater ecosystems—rivers, lakes, floodplains, wetlands, and estuaries—provide clean water, food, fiber, energy and many other benefits that support economies and livelihoods around the world. They are essential to human health and well-being.

Fortunately, the public, and not just the scientific community, now have a better understanding of the inherent ecological needs and associated benefits for retaining portions of water within rivers, lakes, estuaries, wetlands, and groundwater systems and the importance of balancing these needs with human-related uses. And we have the legal mechanisms to marry both. Although we have established various legal and regulatory mechanisms to achieve such, many of these were enacted in locations where most water sources had already been

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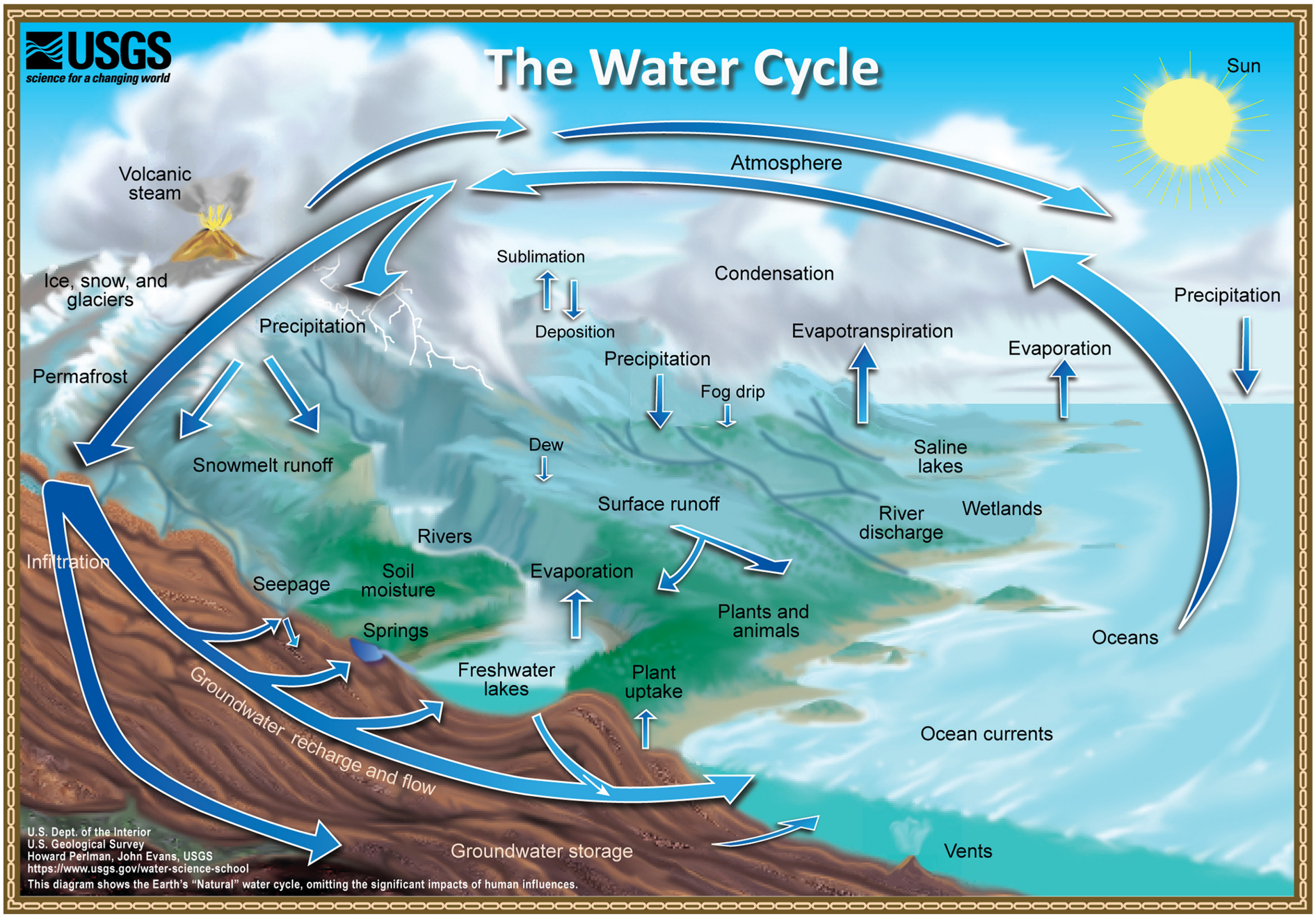

Figure 1. Conceptual watershed illustrating linked surface and groundwater ecosystems and estuaries that displays hydrologic flow paths, interrelationships, and connections between surface (rivers, streams, lakes, wetlands) and groundwater flows as influenced by geomorphic processes within a watershed. Figure adapted from U.S. Geological Survey (USGS; https://www.usgs.gov/media/images/natural-water-cycle-jpg; see also https://labs.waterdata.usgs.gov/visualizations/water-cycle/index.html#/).

significantly or fully allocated. Thus, the ability to successfully execute this balance is complex and further challenged by the global population growth compounded by the recent anthropogenic-induced climate shifts and associated changes (FAO, 2018) that affect hydrologic cycles and associated water quality parameters and their linked surface and groundwater ecosystems and estuaries (Figure 1). Socioeconomic and cultural considerations also factor into all elements related to water allocation issues.

Although water resource engineers and specialists can readily quantify seasonal and long-term water needs for specific uses such as hydropower, agriculture, and domestic water supply, determining the water needs to sustain riverine, lacustrine, and estuarine systems has proven more difficult. Adding to this difficulty is the lack of formalized interdisciplinary training for selecting and applying regionally based methods that incorporate the eight main elements defined by the Instream Flow Council ([IFC]; Annear et al., 2004). These eight elements include five science elements (hydrology, geomorphology, biology, connectivity, and water quality components) in combination with legal, institutional, and public involvement (including socioeconomic) considerations (Figure 2).

This was not always the case. From 1976 through 2001, the CIFSG in Fort Collins, Colorado (described briefly below), played a vital role in developing and promoting the discipline of instream flow conservation (protection, restoration, and enhancement), with an emphasis on lotic habitats. In subsequent years, there has been a growing need to expand the focus to account for hydrologic and biologic connectivity within watersheds and consider not only rivers and streams but also include lakes, reservoirs, wetlands, estuaries, groundwater, and other nonflowing waterbodies as well as associated terrestrial and riparian habitats.

Since 2001, a variety of other sources of independent training has been offered on a periodic basis through various entities and organizations that encompass a portion of the elements described above. Unlike the CIFSG, these other sources of training are designed for targeted audiences and typically do not apply an interdisciplinary approach integrating all of the eight IFC elements. This has created a void in the comprehensive application of existing methods and insufficient development of state-of-the-art methods required to achieve effective instream flow and water level conservation.

Recognizing this void, the IFC and American Fisheries Society (AFS) collaborated in 2019 and obtained a Multistate Conservation Grant. These partners established a 10-person steering committee (Committee) of experts from a range of disciplines to evaluate the need and feasibility of establishing a national training and development center (Table S1). In this

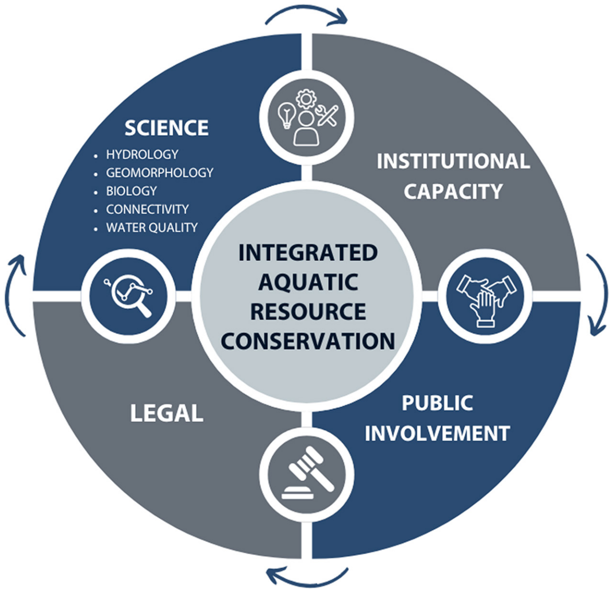

Figure 2. Effective aquatic resource conservation and management is achieved by the integration of eight interdisciplinary elements that include three social elements—legal, public involvement and institutional capacity, and five science elements (hydrology, geomorphology, biology, connectivity, and water quality).

article, we (as members of the Committee) briefly review the past and current offerings of Instream Flow and Water Level Conservation (IFWLC) training and then describe a path forward toward the establishment of the Center.

WHY THE URGENCY?

The regulatory processes that govern water allocation and use decisions require stakeholders to navigate complex scientific, legal, institutional, policy, social, and economic questions, oftentimes without comprehensive formalized training. And yet, in today's and tomorrow's highly competitive water resource arena, these questions cannot go unanswered and should be addressed using a combination of existing and state-of-the-art scientific and technological tools. Although there have been and will continue to be new innovative methods and models developed for addressing water resource issues (briefly described below), their sheer number can create confusion among stakeholders as to which methods to select and how to apply and interpret results. This can compromise their ability to effectively render defensible flow and water level recommendations and negotiate solutions conducive to ecosystem sustainability.

PAST TRAINING OPPORTUNITIES

The U.S. Fish and Wildlife Coordination Act that was passed in 1934 and amended in 1958 requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) on projects pertaining to water management on federal facilities and resources. Equally important, the USFWS Coordination Act requires the USFWS to consult with state fish and wildlife agencies. However, through at least the 1970s, there was a general lack of accepted, comprehensive methods to quantify flow needs below reservoirs. Flow release recommendations were offered, but a lack of standardized approaches often rendered them controversial and ineffective.

To address this, the USFWS, with funding from the U.S. Environmental Protection Agency, hosted a series of workshops to document the state-of-the-art in instream flow science and related training needs. In 1974, the CIFSG was established and was fully staffed by 1976. A symposium and specialty conference was subsequently held in Boise, Idaho, in May 1976 that was jointly sponsored by the Western Division of the AFS and the Power Division of the American Society of Civil Engineers (Orsborn and Allman 1976; https://www.instreamflowcouncil.org/resources/ifc-publications/). The symposium provided a forum for discussing needs and solutions to scientific, technical, legal, social, and economic problems caused by increasing competition for water. One of the more seminal articles was presented by Waters (1976), who described a computer-based incremental approach for evaluating fish habitat and flow needs in California. Many of its foundations were reflected in the later development of the Physical Habitat Simulation (PHABSIM) model (Milhous et al., 1984) and the overarching and widely used Instream Flow Incremental Methodology (IFIM) by the CIFSG.

The CIFSG was viewed as ***the*** authority for methods development and training, and many of its trainees have either retired or moved on to other positions since its closure. The CIFSG researched the connections between the science of hydrology, geomorphology, water quality, and aquatic and fisheries ecology and developed methods and models for quantifying how changes in flow may affect the habitats of fish and aquatic biota. Curricula were prepared and training initially offered for federal, state, and provincial agency employees who were charged with protecting instream flow regimes through interdisciplinary technical, legal, institutional (policy), and public involvement mechanisms. The training courses focused on the general design and conduct of studies; application of specific methods—for example, IFIM; modeling (e.g., PHABSIM and temperature models) and data interpretation; problem analysis and negotiating solutions; providing expert testimony at water rights hearings; and case study analysis—for example, hydropower relicensing. Courses related to legal, institutional, and public involvement focused on the application of laws and regulations on a local jurisdiction and federal basis and how to implement them effectively and identified training in options and opportunities to improve them. Publications were prepared and widely circulated (Figure 3), and training was subsequently expanded and provided to other stakeholders including water resource engineers, hydrologists, lawyers, water policy analysts, consultants, tribal entities, and others. Of note is that the courses all focused on flow, as the CIFSG did not develop methods for deriving ecologically based water levels in lentic waters, something that will be included in a new Center. By connecting the sciences, the concept of instream flow issues became more understandable and acceptable to resource managers and stakeholders. Of paramount importance was that the CIFSG expanded the scope of traditional instream flow objectives beyond minimum single-flow prescriptions to the integration of all the sciences that drive ecological processes.

Figure 3. The Cooperative Instream Flow Service Group located in Fort Collins, Colorado represented the primary information source and training center for stakeholders to obtain instructions, models, and reference materials for addressing instream flow related issues. The Group was operational from 1976 to 2001.

The popularity of PHABSIM and the IFIM developed by the CIFSG expanded internationally and as evidenced by a Google search of keywords *PHABSIM and IFIM*, has been widely applied in many European and Asian countries, South Africa, New Zealand, Australia, Canada, Mexico, and others.

The CIFSG ceased to exist in the early 2000s in part due to departmental reorganization efforts during 1990–1991 and retirements of long-term staff. A comparable national organization for all water use stakeholders has not existed since that time. Recipients of that training have largely retired, creating a growing shortage in skilled IFWLC practitioners.

TODAY'S TRAINING OPPORTUNITIES

Since the closure of the CIFSG, advancements in instream flow methods and models for lotic systems have proliferated from efforts by practitioners across governmental, public, and private sectors. There are already many training opportunities for some IFWLC elements within some graduate and undergraduate university programs, but there is no consistent, comprehensive program that integrates all eight elements and is readily available to stakeholders. Also missing is a centralized independent recognized entity that establishes criteria to assess the credible application, interpretation, and integration of methods/results. Advancements and refinements have been applied largely through efforts of instream flow practitioners, who routinely critique existing and new applications (Beecher et al., 2010; Poff & Zimmerman, 2010; Railsback, 2016; Reiser & Hilgert, 2018; Scott & Shirvell, 1987; Webb et al., 2019).

Today's training opportunities include several sources of governmental, nongovernmental, professional, academic, and private organizations that offer individualized, continuing training courses in one or more of the eight elements. Examples of governmental-sponsored training opportunities include those provided at the USFWS National Conservation Training Center (https://www.fws.gov/program/national-conservation-training-center); the U.S. Army Corps of Engineers Hydraulic Engineering Center's River Analysis System, in particular the Hydraulic Engineering Center's Ecosystem Functions Model that defines relationships between hydrology and ecology and can display results spatially (https://www.hec.usace.army.mil/software/hec-efm/); and the Environmental Protection Agency's Better Assessment Science Integrating Point and Non-point Sources training related to water quality and watershed assessments (https://www.epa.gov/ceam/better-assessment-science-integratingeigh-point-and-non-point-sources-basins).

Examples of nongovernmental organizations include The Nature Conservancy that has developed a set of tools/models that can be applied in addressing water management issues (https://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/Pages/environmental-flows.aspx) and Trout Unlimited that has championed watershed and riverine ecosystem conservation for over 50 years and collaborated with agencies, landowners, and other stakeholders on numerous projects related to instream flow (https://www.tu.org/?s=instream+flow+protection).

The academic and private sectors from the United States and several different countries have also contributed to advancing flow and water science assessment tools; see, for example, the System for Environmental Flow Analysis (Payne et al., 2011; http://sefa.co.nz/), Meso-HABSIM models (Parasiewicz, 2001, 2007), and the Computer Aided Simulation Models for Instream Flow and Riparia (Noack et al., 2013). The System for Environmental Flow Analysis suite of programs was tailored around the same overarching guidance of the IFIM and includes an integrated set of tools that is useful in environmental flow assessments. Developed as a collaborative effort by researchers from the United States (T. Payne), New Zealand (I. Jowett), and Spain (Juan Manuel Diez Hernandez), many of its components mirror those that are available in the IFIM, with separate modules for defining habitat–flow relationships, sediment deposition and flushing flow analysis, and water quality modeling (water temperature and dissolved oxygen; Payne et al., 2011). Meso HABSIM, as its name suggests, was likewise patterned after the IFIM software program Physical Habitat Simulation (PHABSIM) model but is intended to upscale the results to the river and watershed level. Developed by Piotr Parasiewicz of Poland (Parasiewicz, 2001, 2007), this software is available for a fee at Mesohabsim—Instream habitat simulation at river scale (mesohabsim.org). The set of models within the Computer Aided Simulation Models for Instream Flow and Riparia suite developed in Germany by Noack et al. (2013) employs a fuzzy-logic modeling approach for evaluating conditions of aquatic ecosystems under different flows (http://www.casimir-software.de/ENG/publications_eng.html). In addition to fish habitats, the models consider aquatic benthic organisms as well as floodplain vegetation.

In the United States, the Individual-based Stream Trout (inSTREAM) and Salmon (inSALMO) Environmental Assessment models (Railsback et al., 2009, 2021; https://ecomodel.humboldt.edu/instream-and-insalmo-overview) take a different approach to environmental flow assessment, focusing more on how fish populations may respond to flow modifications rather than on habitat. The models represent a promising approach for taking environmental flow analysis a step beyond habitat and into population-level effects. Their field data and analysis requirements are comparable to those of thorough PHABSIM studies.

Also in the United States, the Ecological limit functions (ELF) describe relations between flow and species richness that are predicted by the river continuum concept. The ELF framework, employing a fish monitoring database, provides an alternative method for assessing the effects of flow depletion, without the need for extensive habitat characterization or in-depth flow modeling (Kleiner et al., 2020; Rapp et al., 2020). The ELF framework (https://github.com/HARPgroup/elfgen) can prioritize water withdrawal permits at regional scales from estimates of withdrawal amounts, which could be potentially protective of species richness.

There are other methods, and new ones will continue to be developed to address novel and ongoing concerns such as the effects of groundwater withdrawals (Arthington, 2022), hydropeaking (Smokorowski, 2022), and ice formation and breakup (Thellman et al., 2021) on aquatic ecosystems.

Formalized techniques for assessing ecologically based water level requirements for lentic habitats are beginning to emerge, with examples of project-specific approaches being applied in Alaska, Alberta, Colorado, Florida, Idaho, Nevada, Oregon, and other locations. The Center will focus on the integration of all eight elements for both lentic and lotic systems as well as freshwater inflow regimes and their receiving water regimes (estuaries, wetlands, lakes, etc.).

WHAT DO POTENTIAL USERS THINK?

The opinions of potential users of a new Center were solicited via an internet survey in 2021 that consisted of questions that were designed to determine their experience, extent of training related to instream flow, and level of interest in Center establishment. This survey was distributed widely via the internet to numerous organizations with water management interests.

The main findings are as follows:

- In total, 486 people participated in the survey. Nearly 95% of the participants indicated support for establishing a training, research, and support Center that would promote integration of multiple disciplines in flow and water level prescriptions (Figure 4).
- Of the 475 people who responded to this question, 346 (73%) have been doing this work for 20 years or less. This indicated that most respondents did not get training directly from the CIFSG.
- There was wide diversity in the affiliations of respondents, with 17 distinct categories ranging from financial investment to those representing state/provincial government (Figure 5). The top four affiliation categories of respondents included state/provincial, federal, nongovernmental organizations, and academic.
- Most survey participants said they already possessed some skill in the eight elements noted above, but they also expressed strong interest in additional training in all those elements.

The results reaffirmed feedback received by Committee members from contacts in federal and state agencies, tribal entities, nongovernmental entities, and the academic and private sectors that, currently, there are no comprehensive and consistent interdisciplinary training opportunities in North America. Clearly, a Center is needed that would differentiate itself from other training programs by promoting the integration of all eight elements to inform the regulatory process of the implications of resource allocations on the ecological integrity of affected freshwater ecosystems. The Center's collaborative networking with universities, national research centers, and private industry that engage in research and development and application of new methods would further enhance the Center's function and effectiveness.

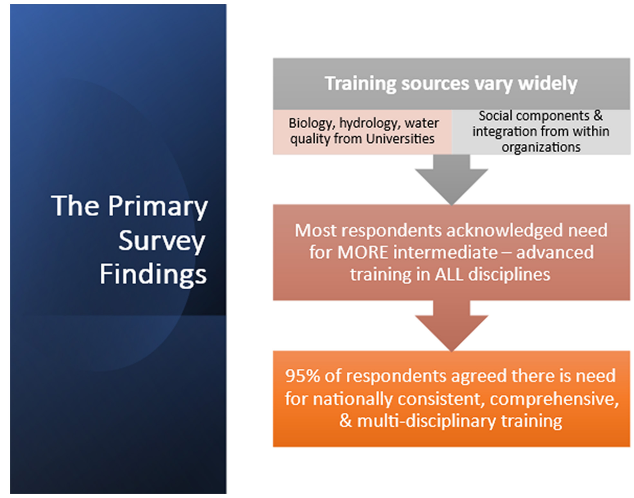

Figure 4. Internet survey findings revealed a strong interest in and a recognized need for establishment of a Center for Ecologically Sustainable Water Conservation and Management. Details of survey questions and responses available: https://bit.ly/4hFb7tD.

ALTERNATIVES FOR CENTER ESTABLISHMENT

Three main considerations factored into the feasibility assessment of the Center: (1) identification of potential

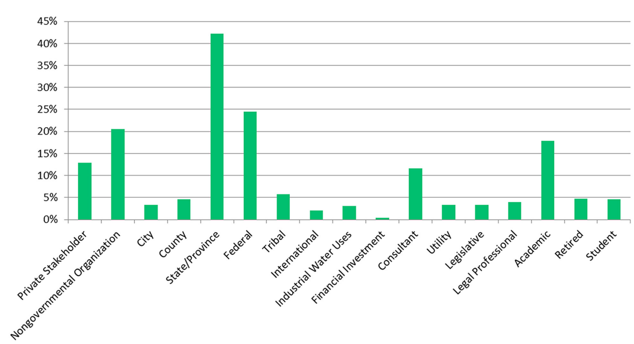

Figure 5. Internet survey findings revealed a diversity of respondent affiliations, with the top four represented by State/Provincial (43%), Federal (24%), Nongovernmental Organization (21%), and Academic (18%). There was a total of 483 respondents to this survey question.

users/customers of the Center, (2) organization and management of the Center including where and how it would generally function, and (3) approaches for securing funding to operate and maintain the Center.

Customers of the Center

Support for the Center was affirmed across a broad spectrum of potential customers/stakeholders including governmental and nongovernmental entities, private businesses, universities, citizen groups, research laboratories, and private individuals. Stakeholders also included international entities who supported establishment of the Center and the support services and training it will offer. The strategic need for the Center is imperative given turnover of staff across the full spectrum of stakeholders.

Organization and management approaches

For planning purposes, the feasibility of four administrative concepts were considered (Figure 6), with the Pros (+) and Cons (−) of each summarized in Table 1. The approaches range from a centralized and traditional "brick and mortar" concept in which the Center would be housed in a fixed location that offers in-person training, to a decentralized concept in which virtual training offerings would be provided via a network of personnel from multiple host institutions. A hybrid approach was also considered that encompassed elements of both in-person and virtual training. The fourth approach considered joint sponsorship with an existing entity such as The Nature Conservancy that has pioneered and provides training in several environmental flow models and methods.

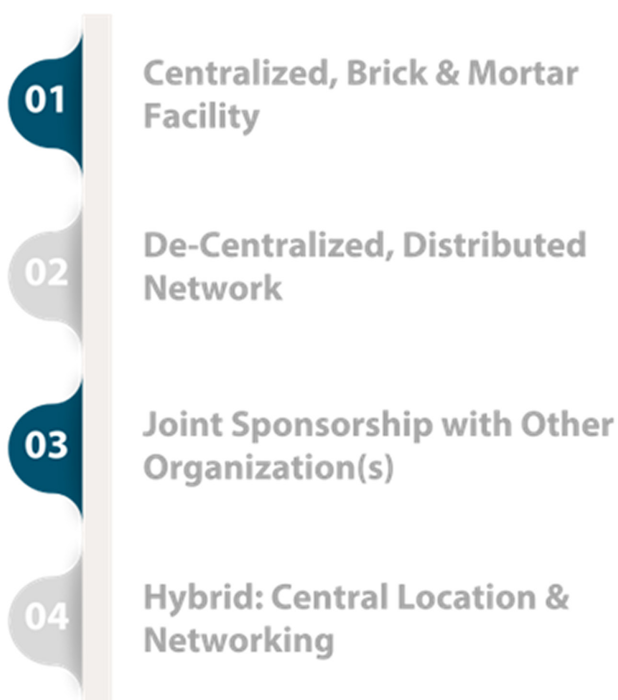

Figure 6. Four Options considered for implementation of the Center for Ecologically Sustainable Water Conservation and Management. The Committee selected Option 04 as the alternative providing the greatest opportunity for the successful establishment of the Center.

Each of the four concepts was evaluated in terms of implementation costs (start-up and operations and maintenance), staffing requirements (both technical and administrative), management structure, and ease of implementation (Table 1). The Centralized concept would be most like the original CIFSG but would carry the highest costs and face the greatest challenge in terms of selecting a location and filling staffing needs. The decentralized, distributed network concept would provide greater flexibility in meeting staffing requirements and provide greater outreach potential by having a geographically diverse team of instructors. A centralized, distributed network approach would operate similarly but would include a single centralized location that houses core administrative and technical staff and would serve as a hub to regionally based satellite centers (other universities). The latter two concepts would lower start-up costs and allow for a "phased" implementation process. Thus, training could start small with a core team of instructors and could expand as needed to increase instruction and/or diversify training modules. The fourth concept, joint sponsorship, recognizes that other stakeholder organizations (e.g., The Nature Conservancy) are actively involved in the development of environmental flow and water level models and would seek to consolidate these with the Center to provide more comprehensive training opportunities. This concept would rely on negotiations with them and defining roles and responsibilities that are mutually beneficial and agreeable to both entities.

Potential funding options

The specifics of funding needs, sources, and financial mechanisms will evolve based on the actual implementation strategy(ies) selected for the Center (Table 1). Although a single approach to initiate the program is envisioned, other strategies may prove feasible depending on requirements of host or partner institutions, requirements of potential funding sources, demand for services, and the rate at which full-scale training and related services are developed. Dedicated short- and long-term funding will be needed because the Center may not be self-sustaining on training fees alone. Several different funding concepts were considered:

Governmental agency concept

Under this concept, the Center would be supported entirely by one or more governmental agencies, much like the original support provided by the USFWS for the CIFSG. Funding would be from a congressionally dedicated agency budget protected from defunding or redirection for other purposes.

Center staff would collaborate with other federal entities and leverage funding where possible training opportunities exist. However, no federal entities are currently engaged in providing consistent training in the integration of all eight elements to inform IFWLC recommendations, assessments, and mitigation strategies.

Private/philanthropic concept

This concept offers the potential to secure the desired long-term revenue stream and the ability to structure a Center that is more independent of outside socioeconomic and political

Table 1. Options considered and benefits and risks of each for the organization and management of an instream flow and water level conservation center. The options listed and associated pros and cons are those identified by the committee as most conducive for meeting the overall objectives of an IFWLC Center. There may be other options, and the committee is open to evaluating other concepts as they are identified.

Option and description	Pros (+)	Cons (−)
Centralized–Brick and mortar: Buy, build, or lease a facility to house the Center; location to be determined but favor university setting that would provide flexibility in office space. This option most closely resembles the operation of the former CIFSG in Fort Collins, Colorado.	• Establishes physical presence and identity/brand of the Center although would need decision on whether to own or lease facility • Majority of Center technical staff in close proximity to the facility and would facilitate intra-staff collaboration, curricula development, and planning • Center includes dedicated in-house training facilities (no competing interests to work around) • Could ultimately serve as a central clearing house for disseminating IFWLC related information and promoting and implementing new and innovative approaches for addressing IFWLC issues	• **Mostly cost related**, as startup and operations costs would be high including: – large initial capital costs for infrastructure, although university setting would obviate the need for major construction. – Unless already present at selected facility, identifying, hiring, and sustaining full-time requisite technical and administrative staff would be lengthy and costly. – Ongoing operation and maintenance costs (utilities, supplies, administration, insurance, etc.). – Disbandment and closure of the Center could be complicated and costly. • Centralized presence in one location may geographically bias the focus of the training; however, this could be avoided/reduced by conducting regional workshops and video-training. • Would likely require lengthy start-up time before Center becomes fully operational.
Decentralized–Distributed network: Use a distributed network composed of selected personnel from one or more host institutions at one or more locations to cover the required training disciplines. These could be federal, state, provincial, private, or university locations and personnel.	• Provides a geographically diverse portfolio of multidisciplinary expertise • Provides flexibility in staffing to meet evolving water resource issues • Softens the need (and cost) for full-time staffing • Infrastructure already exists and averts the need for one physical location of the Center • Reduces singular financial risk as operational costs shared among participating organizations • Shortens time frame for implementation of training modules; e.g., some initial courses could be offered in the near-term • Allows for "phased" implementation—start small and build network as demands increase	• Center "identity" less defined and may need different brand; e.g., IFWLC as in Consortium instead of Center. • Limited opportunities for in-person brainstorming and collaboration, which may hamper future planning and curricula development. However, establishing a network of personnel with a shared vision of objectives should reduce such limitations. • Management is potentially more difficult (as a function of who is involved). • Imposes structural challenges to sustained or focused collaborations. • Personnel turnover could be problematic, especially if specialty topics are reliant on single instructors, i.e., no backup. This indicates all courses should have at least two instructors available (and substitutes if possible) who could each singly instruct the course. • Everyone potentially has their own day job.
Centralized–Distributed network: Establish a central base of operations (hub) for administrative and planning purposes that is linked to a distributed network composed of selected personnel from one or more host institutions at one or more locations to cover the required training disciplines. This option would fit best within a university framework whereby one university would serve as the hub, with others strategically located at regionally based institutions.	• Provides a central hub with administrative and technical staff to develop training modules and coordinate between other satellite institutions • Center "identity" better defined via existence of central hub • Provides a geographically diverse portfolio of multidisciplinary expertise • Provides flexibility in staffing to meet evolving water resource issues • Infrastructure already exists and averts the need for one physical location of the Center • Reduces singular financial risk as operational costs shared among participating institutions • Shortens timeframe for implementation of training modules; e.g., some initial courses could be offered in the near-term • Allows for "phased" implementation—start small and build network as demands increase	• Some upfront increased costs due to full-time staffing of central hub. • Imposes structural challenges to sustained or focused collaborations. • Personnel turnover could be problematic, especially if specialty topics are reliant on single instructors, i.e., no backup. This indicates all courses should have at least two instructors available (and substitutes if possible) who could each singly instruct the course. • Strict administrative oversight needed to ensure collaboration and consistency among instructors.
Joint Sponsorship with other stakeholder organizations: Others already may have a prominent role in water resource management and development of instream flow/water level models and methods.	• Builds on and enhances existing platforms of environmental flow/level training and strategies • Consolidates separate training modules so that training opportunities can be more comprehensive	• Requires strong relationship and shared vision between parties; unless this already exists, this would take time to develop. • Increased complexity in defining roles and responsibilities and curricula development.

forces. The flexibility afforded by such an approach is both a challenge and a potentially significant benefit. This approach could be sufficient to hire a few permanent staff and engage experts (instructors) on long-term retainers. Compensation would be based on the effort provided by each one but needs to be adequate to ensure that instructors are qualified and would remain engaged for at least 2–3 years to ensure the full development of the curriculum and training materials and support continuity in training concepts. This approach might appeal to experts who wish to retain their existing jobs but provide services to the Center on a part-time basis or work on a job-share basis from a federal agency, research center, or university. This approach could be supplemented with government grants or contracts with states, tribes, and federal agencies and fees from participants.

Cooperative concept

The cooperative concept offers favorable elements from each of the above strategies. An interdisciplinary and cooperative facility comprising, for example, a university, private foundation, government agency, and rotating expert staff offers several potential advantages. The United States Geological Survey Cooperative Fish and Wildlife Research Units (of which there are 40 located in 38 states) and the National Conservation Training Center are examples, as was the CIFSG. A cooperative approach where the Center is hosted at a university with a cooperative fish and wildlife research unit or water center could provide for a semipermanent organization that is perceived as adding scientific expertise and national recognition to the agreement partners. The Center could also offer training to university students and help jumpstart the careers of next-generation practitioners.

University space and staff appointments have the advantage of allowing collaboration with other university staff to help obtain and process grants in addition to providing other functions of the Center. Under such a cooperative arrangement, if, for example, a federal agency was to withhold funding, the Center could continue to function if private funding was also a major component of the program. As the objective of the Center is to establish an interdisciplinary program, those institutions having Water Laboratory/Water Resources Research programs, Cooperative Fisheries Research Units, or other similar units might offer desirable settings for the proposed Center. The proposed Center that embraces biology, hydrology, earth sciences, water quality, and engineering sciences, supplemented by legal, institutional, and public involvement curricula would likely bring strong private support.

CENTER FUNCTIONS

The Center will provide several functions (Figure 7):

- Centralized Leadership: The Center will continue the IFC/AFS collaborative leadership role that has been established over the past 2 decades representing and serving the water management and ecological conservation community and ensuring that the Center adheres to its stated goals and objectives. This will include providing guidance on the application and integration of appropriate tools and strategies for applying all eight elements to understand the implications of water allocation decisions and options to sustain aquatic resources.
- Interdisciplinary and Integrated Training: The Center would engage instructors and prepare state-of-the-art curricula, guidance manuals, analytical techniques, and interdisciplinary courses covering the ecological components that are necessary for addressing flow and water level needs for protecting and/or documenting the consequences of water management practices. The same general precepts that were applied with the original CIFSG will be followed in curricula development, but they will be updated and expanded to accommodate the latest technologies, including the application of AI-based models. Research for instream flow and water level conservation is inherently data and model based, and it will be important to make modeling approaches and methods that are developed in other engineering and ecological fields available to practitioners.
- Research and Development: The Center would continue support for existing methodologies and engage in collaborative development, testing, application, and interpretation of new methods and strategies for achieving ecologically sustainable water conservation and management.
- Support and Networking Services: The Center will promote networking, provide a clearinghouse function, document up-to-date information and evolving techniques, track ongoing water project studies, give advice, review project plans of a study on request, and circulate periodic reports on the state-of-the-art and practices related to water conservation and management.

Figure 7. Primary functions of the Center for Ecologically Sustainable Water Conservation and Management.

Additional roles and responsibilities will be added as the Center becomes fully operational and stakeholder needs are clarified.

STAFFING AND GOVERNANCE

The envisioned full-time Center staff include a Leader and Assistant Leader, providing a balance in aquatic ecology and complementary expertise in hydrology, engineering, geomorphology, and/or social sciences. An Administrative/Training Coordinator will be needed for assisting in budgeting, arranging travel, coordinating classes, and other routine details. An Executive Governing Board consisting of IFC and AFS members will be established to ensure that all eight elements are represented in training. This Board will be helped by an Oversight Board and Science Advisory Committee as described in a Governance Charter for the Center.

PATH FOR IMPLEMENTATION

Of the various implementation alternatives considered (Table 1), the Committee believes the most effective would be housing the Center within a university or research facility with shared interdisciplinary objectives for natural resource conservation, management, research, and law.[1] The Center will function as a centralized, distributed network, featuring both virtual and in-person training, service, and integration of emerging research and development into advancing the state-of-practice for ecologically sustainable water conservation and management. The core personnel and operations would be supported through the establishment of an endowment and supplemented with grants and contracts from private, state, federal, provincial, and tribal programs. Given the pressing needs for training, initial efforts would target the development of training modules for basic, introductory aspects of the eight elements. Within the first few years, more complex courses in each element would be developed and offered.

After establishing the Executive Governing Board, the implementation process would occur in four phases:

- Phase 1. Nonprofit Designation and Funding Acquisition: Immediately begin securing status for the Center as a nonprofit tax-exempt entity. Regardless of available funding at the outset, this designation is needed to afford tax-exempt status and facilitate the receipt of donations and other financial assistance. Several possible sources of funding for the Center have been identified, and these and others will be evaluated.
- Phase 2. Near-Term Training and Initial Center Launch: Establishing a formal entity would allow the executive governing board to endorse training activities that are conducted on an intermittent basis by select individuals and build proof of concept. This would provide a bridge to the establishment of a centralized physical location and the recruitment of more long-term instructors and administrators. During this phase, promotional materials highlighting the Center launch would be developed and widely circulated, providing a brief description of the Center facilities and a listing of future training opportunities and courses.
- Phase 3. Identification of and Hiring Core Staff and Administrators: This would evolve when the Center secures short-term funding to support three full-time centrally located staff consisting of a Leader and Assistant Leader and an administrative coordinator, along with three strategically located contract instructors to represent regional IFWLC issues. This core group of people would develop formal curricula and related training materials and conduct training according to the centralized, distributed network format described above.
- Phase 4. Full-Scale Center Operations: Having firmly established proof of concept, long-term, stable funding would be secured to support all the administrators and instructors that are identified in Phase 2 as permanent employees. Over time, the remote regionally based instructors would transition from working as a single collective group to developing an expanded training curricula specific to a given region, with additional regionally based instructors added to the network as needs dictate.

THE END OF THE PATH IS JUST THE BEGINNING

One of the realities the Committee faced while exploring and planning for the establishment of a formalized training Center is that there really is not a single pathway for its achievement but rather multiple routes, each with its own set of risks and Pros (+) and Cons (−) regarding its potential success. Clearly, there will be many challenges along the road to implementation including but not limited to identification and selection of a host institution or organization and an agreed-to governance charter, securing short- and long-term funding sources for operational costs including administrative support and salaries for instructors, recruitment of instructors and development of curricula and training materials, establishing network affiliates to the host to expand research and provide regionally based training opportunities, and others. The pathway described in this article represents more than 2 years of deliberative exploration and planning by the Committee, and we believe it provides the greatest opportunity for the successful establishment

Penobscot River (fall), Maine: Photo credit: Brandon Kulik.

[1]The Committee has already begun exploring this alternative through requests for letters of interest and qualifications from universities, research organizations, and institutions having a potential interest in and ability to host the Center. Actions to secure funding for the Center are being implemented independently of the Multistate Conservation Grant project.

Rock Creek, Wyoming. Photo credit: Tom Annear.

of a Center. However, identifying the selected pathway does not by itself lead to success but rather just provides a roadmap that could lead to success (i.e., destination) if actively traveled/followed. To be sure, other routes exist. And, although there will be a certain amount of uncertainty with whatever path is ultimately selected, there is no uncertainty regarding the immediate need for the Center. Yes, a pathway for establishing a Center has been identified, what is needed now is to begin the trip.

More detailed information about the feasibility of this Center can be found on the Instream Flow Council website at www.instreamflowcouncil.org and in the October 2023 *Feasibility Assessment* report (Weedman et al., 2023). Also note that on November 16, 2024, the IFC and AFS posted a request for statements of interest and qualifications (RFIQ) from institutions and organizations that wish to be considered for hosting the Center. Applications are due January 21, 2025. For further information, see https://www.instreamflowcouncil.org/training-center-rfiq/.

> What I have come to appreciate is that water does touch everything. . . . It touches and is touched by politics and governance and policy and law and economics and culture and history and how we live in our communities. . . . Many people don't really perceive how central water is and how it runs through so much of our society. (p. 165)
>
> –Jennifer Pitt, Colorado River Program Director, the Audubon Society

Saluda River, South Carolina. Photo credit: Kleinschmidt Associates.

Allen River and Chikuminuk Lake (background), Alaska. Photo credit: Dudley Reiser.

Coeur d'Alene Lake, Idaho. Photo credit: Kleinschmidt Associates.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Fisheries* online.

DATA AVAILABILITY

Details of the survey questions and responses can be found at IFWLC_Feasibility- Report- 2023.10.pdf (instreamflowcouncil .org).

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CONFLICTS OF INTEREST

None declared.

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