Public Ownership of US Streambeds and Floodplains: A Basis for Ecological Stewardship

BRUCE B. DYKAAR AND DAVID A. SCHROM

Larger US river–floodplain ecosystems are severely degraded. We analyze how public proprietary interests in streambeds and floodplains afford enormous untapped opportunity to protect them. We estimate that states hold in trust for the public approximately 500,000 kilometers of streambeds and hundreds of thousands of hectares of island-derived floodplains that continue to form at thousands of hectares annually. We find that although courts in 42 states have enforced public proprietary interests in submerged lands and floodplains, only three states have inventoried public streambeds, and no state has a comprehensive program to find, claim, and manage public streambeds and floodplains. We describe a legally and scientifically sound strategy to limit human interference with fluvial geomorphic processes, thereby regenerating diverse habitats and securing their myriad benefits, and we show how numerous successes in claiming and protecting public submerged lands and floodplains in dozens of states confirm the validity and power of this strategy.

Keywords: streambeds, floodplains, fluvial geomorphic processes, habitat regeneration, public trust doctrine

In the United States the public holds ownership interests in hundreds of thousands of kilometers (km) of streambed and hundreds of thousands of hectares of floodplain. Through erosion and sedimentation, streams annually generate thousands of hectares of new floodplain wholly or partially owned by the public. Though the majority of public streambed and floodplain is held by states as trustees, no state has thoroughly inventoried, let alone claimed, these assets.

Scientists have demonstrated that fluvial geomorphic processes—erosion, deposition, and flooding—underpin stream–floodplain ecosystems by creating dynamic mosaics of aquatic and terrestrial habitats that support diverse species. Maintenance of these processes is key to ecosystem integrity (Rood and Mahoney 1990, Ligon et al. 1995, Huggenberger et al. 1998, Van Steeter and Pitlick 1998). Strategies to restore the capacity of degraded stream–floodplain systems to generate benefits without also restoring fluvial process function have yet to prove effective (figure 1; Williams et al. 1999). Public proprietary interests in streambeds and floodplains afford a legal basis to limit human interference with fluvial processes and thereby protect habitat on a broad scale. Such actions are essential to arrest or reverse declines in ecosystem services.

Enforcing public ownership to promote ecosystem recovery is fraught with challenges. In some states, rights of public owners have been compromised or remain ill defined. Competing public and private claims to streams and floodplains are deeply entrenched and vigorously pressed. Only a handful of people are aware of the extent of public ownership or of the critical role of fluvial processes, and still fewer recognize the synergy between science and law in this realm. However, these and other challenges are being surmounted, and public ownership is emerging as a key element in ecological stewardship strategies for stream–floodplain ecosystems.

Public streambeds

Under the Constitution, each state when it entered the Union took title to lands underlying navigable waters (stream, lake, and tidal) to the ordinary high-water line *(Shively v. Bowlby,* 152 U.S. 1 [1894]). In states derived from the original 13 colonies, significant amounts of streambed may be privately owned as a result of grants made during the colonial period *(Commonwealth of Virginia v. Morgan,* 225 Va. 517 [1983]). Elsewhere, a state's title to submerged lands has been defeated in rare circumstances by prestatehood conveyance or reservation by the federal government *(Utah v. United States,* 482 U.S. 193 [1987]). Generally, however, states' authority over

Bruce B. Dykaar (river@ecohydrology.com) is a senior scientist at Ecohydrology West, Santa Cruz, CA 95060. David A. Schrom (river@ecomagic.org) is a senior fellow at Magic, Inc., PO Box 15894, Stanford, CA 94309. The authors share an interest in learning how ecology may be applied to discern and to realize value.

navigable waters is subject only to federal power to regulate interstate and foreign commerce *(Oregon v. Corvallis Sand and Gravel,* 429 U.S. 363 [1977]).

Federal law defines "navigable waters" for title purposes. Tidally influenced portions of streams (i.e., estuaries) are navigable *(Phillips Petroleum Co. v. Mississippi,* 484 U.S. 469 [1988]). Otherwise, streams are navigable if, at the time the state in which they lie was admitted to the Union, they were "used, or [are] susceptible of being used, in their ordinary condition, as highways for commerce" *(United States v. Utah,* 283 U.S. 64 [1931]). Streams have been found navigable on evidence ranging from log drives to recreational boating and despite natural impediments, such as shifting bars and seasonally insufficient flow *(United States v. Utah,* 283 U.S. 64 [1931], *Oregon v. Riverfront Protection Association,* 672 F.2d 792 [1982]). They may be proven navigable experimentally or by measurement of physical characteristics *(United States v. Utah,* 283 U.S. 64 [1931]).

Indiana, Montana, and South Carolina are the only states to have completed programs to locate navigable streams. Indiana and Montana found 5224 and 5211 stream km, respectively, solely by cursory examination of historical use, without consideration for susceptibility of use (State of Montana 1997, State of Indiana 2002). On the basis of historical use and of field surveys of stream width, depth, and flow to assess navigable capacity, South Carolina found 7422 stream km (Jeffrey Havel, South Carolina Department of Health and Environmental Control, Myrtle Beach, SC, personal communication, 2002; State of South Carolina 2002).

We calculate total length of navigable streams in the contiguous 48 states by taking Indiana, Montana, and South Carolina to be representative, summing the lengths of the streams identified within these three states, dividing by the states' combined land area to find an average navigable stream density of 0.033 stream km per square km, and then multiplying this average by the land area of the lower 48 states to yield an estimate of 250,000 stream km. Our average density and total length estimates are probably very conservative, because some difficult-to-access South Carolina streams remain unsurveyed and because Indiana and Montana, by neglecting to consider navigable capacity, omitted some of the smaller streams, which typically make up most of the stream length in a river network.

A federal court held a stream in Alaska navigable on the basis of its capacity to float lightweight recreational boats (including inflatable rafts 4 to 7 feet wide) during the summer, when the stream is not frozen *(Alaska v. Ahtna, Inc.,* 891 F.2d 1401 [1989]). Relying upon this and other courts' decisions, the Alaska legislature has asserted that the state owns the beds of "massive numbers" of navigable waterways in trust for the public (Alaska State Legislature, House Bill No. 266 2001, Senate Bill No. 219 2001). Proponents of legislation to further these claims estimated more than 22,000 streams and 1 million lakes (sponsors' statement, House Bill No. 266 2001). There may be more kilometers of navigable streams in Alaska than in the rest of the states combined.

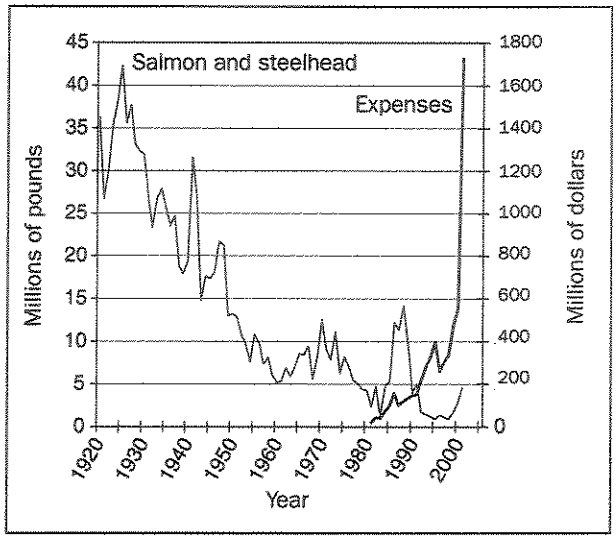

Figure 1. Annual Bonneville Power Administration expenditures on fish and wildlife improvements in the Columbia Basin contrasted to annual commercial landings of salmon and steelhead from the Columbia River (Federal Caucus 1999, BPA 2002). "Wild fish abundance is approximately 1% of historical predevelopment abundance" (Williams et al. 1999, p. 11).

Public floodplains

Initial property boundaries between public streambeds and adjacent floodplains were established at the moment of statehood, and delineating these is a matter of federal law *(Oregon v. Corvallis Sand and Gravel,* 429 U.S. 363 [1977]). Thereafter, when a shoreline changes by gradual accretion or erosion, property boundaries move with it *(Arkansas v. Tennessee,* 246 U.S. 158 [1918]). To gain ownership by accretion, two requirements must be met. First, the process must be gradual, meaning new lands are built by "alluvial formations," which change the course of a stream *(Missouri v. Nebraska,* 196 U.S. 23 [1904]). Second, sediment deposits must begin and form contiguously upon property of the party claiming new land *(Jeffries v. East Omaha Land Co.,* 134 U.S. 178 [1890]).

A streambed owner is entitled to islands arising from it (Marvel 1957). Numerous navigable streams (e.g., the Colorado, Missouri, Snake, and Willamette Rivers) build islands that originate as within-channel sand or gravel bars and eventually coalesce with mature floodplain (figure 2; Merigliano 1996, Van Steeter and Pitlick 1998, Dykaar and Wigington 2000). Though not all navigable streams' beds are wholly owned by the public, either because of pre-statehood grants, conveyances, and reservations (noted above) or because some states have conveyed "bare title" (described below), an island formed by accretion upon the bed of a publicly owned streambed is public property (Marvel 1957). The sequence of ambulatory property boundaries accompanying the development of a within-channel bar into floodplain (shown in

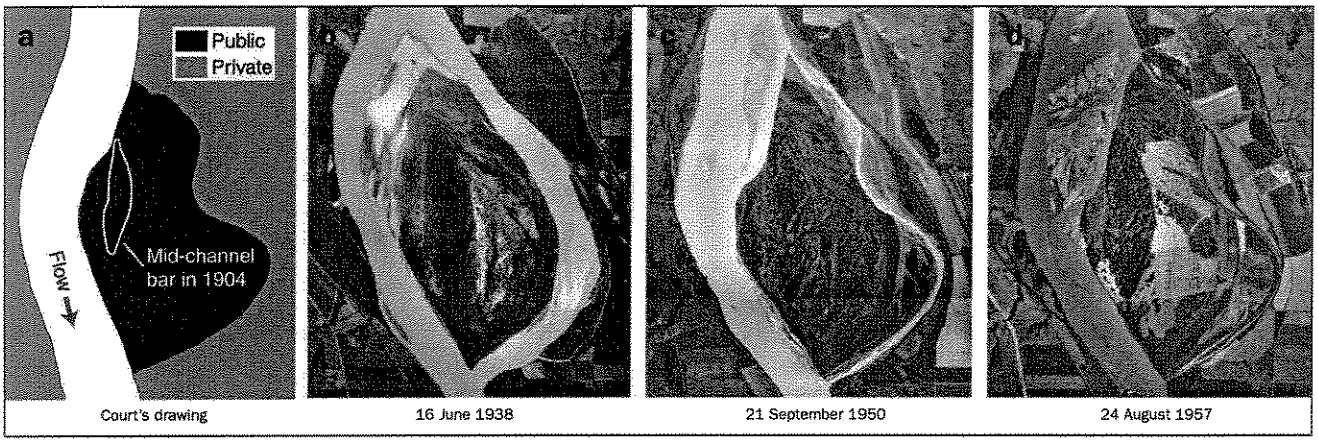

Figure 2. In 1955 the North Dakota Supreme Court found the Missouri River island shown in the aerial photographic sequence to be the property of the state* (Hogue v. Bourgois, *54 A.L.R.2d 633 [1955]). (a) Illustrative sketch drawn by the court showing geomorphic evolution of the midchannel bar from 1904 to 1950 and final property boundary between the public island and private mainland in 1950. (b), (c), and (d) Aerial photographs of the site.

figure 2) illustrates how publicly owned islands can become mature publicly owned floodplain.

Island formation is becoming more widely recognized as a source of mature floodplain. It is the dominant mechanism of floodplain formation on some sections of wandering gravel bed streams, serves as a basis for point bar formation on some meandering rivers, and sometimes initiates meanders in straight channels (Lewin 1976, Hooke 1986, Merigliano 1996, Dykaar and Wigington 2000).

We found no published rates of island formation for any stream. Examining a 12 km reach of the navigable Willamette River for the period 1959 through 1998, we discerned production of approximately 1.1 hectares of island per river km per year (figure 3). A 54 km reach of the navigable Snake River generated 0.31 hectare per river km per year over an 80-year period (Merigliano 1996; Michael Merigliano, University of Montana, Missoula, MT, personal communication, 2002). Higher rates probably prevailed on both the Willamette and the Snake prior to damming and bank hardening. Island formation has almost certainly generated hundreds of thousands of hectares of publicly owned floodplain, and it continues to generate thousands more hectares each year.

The public trust doctrine

The beds of navigable streams are held in trust by each state, and states' trusteeship duties beyond a federally imposed baseline are defined by their own judiciaries' articulation of an evolving "public trust" doctrine (*Shively v. Bowlby,* 152 U.S. 1 [1894], Sax 1970, *Arizona Center for Law in the Public Interest v. Hassell,* 837 P.2d 158 [1991]; Slade et al. 1997).

The US Supreme Court has interpreted the public trust doctrine to bar "substantial impairment of the interest of the public" *(Illinois Central Railroad Co. v. Illinois,* 146 U.S. 387 [1892], *Shively v. Bowlby,* 152 U.S. 1 [1894]). Courts have long held this interest to be inalienable *(Arizona Center for Law in the Public Interest v. Hassell,* 837 P.2d 158 [1991]). Though a state normally can dispose entirely of public lands, it may usually convey only "bare title" to a navigable water's bed. Such title confers ownership encumbered by the public trust as if by easement (Slade et al. 1997). Twenty-eight states totaling 78 percent of the nation's land area retain streambed title to high or to low water; 19 states have conveyed bare title; law in Colorado, Hawaii, and Wyoming is silent on streambed ownership (figure 4).

Courts have held that islands arising by accretion from the bed of a navigable stream to which the public retains title are part of the trust resource and remain so, even if they become joined to mature floodplain *(Kansas v. Berk,* 284 P. 386 [1930], *State of Iowa v. Sorensen,* 436 N.W.2d 358 [1989]). We found no court decision on point for states that have alienated bed title; however, beds and banks of such streams remain part of the trust resource, and courts generally conform proprietary interests in islands to those of the beds from which they arise *(Mississippi v. Arkansas,* 415 U.S. 289 [1974]). Also, other geomorphic elements within a floodplain, such as oxbow lakes, have been found to remain part of the trust resource regardless of bed title status *(Dycus v. Sillers,* 557 So.2d 486 [1990]).

Public interests in trust assets have been strongly enforced by the courts. Defeating public claims by adverse possession is difficult, as illustrated by court findings that a long failure to inventory and claim trust assets poses no bar to doing so later, even if in the interim the assets have been placed on the tax rolls *(Kansas v. Berk,* 284 P. 386 [1930]; Slade et al. 1997).

State trusteeship

Each state's specific trusteeship obligations are defined by its judiciary. We found 42 states where courts have invoked the public trust doctrine *(Lake Sand Co. v. State,* 120 N.E. 714 [Indiana 1918], *Kansas v. Berk,* 284 P. 386 [1930], *Arizona Center for Law in the Public Interest v. Hassell,* 837 P.2d 158 [1991] and 38 states cited therein, *Groves v. Secretary of the*

Department of Natural Resources and Environmental Control, C. A. No. 92A-10-003 [Del. Super. Ct. 1994]). All have upheld traditional rights to navigate, fish, or conduct commerce. In recent decades, some courts have enforced additional rights (e.g., recreation, environmental quality) and have deemed it necessary to impose restrictions (e.g., maintenance of flows in tributaries) on activities occurring beyond the boundaries of the trust assets themselves (*National Audubon Society v. Superior Court of Alpine County*, 658 P.2d 709 [1983]).

Though many states have strongly asserted trustee authority in isolated cases, most have fulfilled trustee responsibilities inconsistently. States have renounced claims to (quitclaimed) public islands, thereby enabling private parties to take title to them. States also have allowed trespass—often in the form of hard structures that disrupt fluvial processes—and permitted activities such as gravel mining that carry a large risk of ecological degradation (Bravard et al. 1986, Norman et al. 1998).

For example, in Washington two kilometers of channel of the East Fork Lewis River were abandoned because of a single mining pit capture. This abandonment eventually will result in the transportation of over 2 million cubic meters of bed material to fill the deep pit (Norman et al. 1998). Upstream salmon and steelhead spawning habitat is being destroyed, and creation of downstream habitat is being foregone (Norman et al. 1998). Yet in this instance as in many others, the state has failed to exact, or even demand, compensation for damage to public property.

Army Corps of Engineers

Lacking their own comprehensive stewardship programs, states rely heavily upon the Army Corps of Engineers, which exercises primary federal regulatory authority over public streams. The Corps's mandate, however, does not include fiduciary responsibility to public owners, so the Corps does not defend public proprietary interests against private claims (Code of Federal Regulations [CFR], title 33, part 320).

In fact, the Corps expressly distances itself from ownership issues (CFR, title 33, part 320.4[g][6]). It assumes private riparian owners have a "general right to protect property from erosion," assures owners that "applications to erect protective structures will usually receive favorable consideration," and routinely permits, without explicitly noting that it is doing so, trespass onto public property in the form of riprap (bank hardening), groins, flow deflectors, and other structures (CFR, title 33, part 320.4[g][2]).

Though required by the Clean Water Act to conduct cumulative impact assessments, the Corps lacks resources and legislative guidance sufficient to this complex task and has permitted tens of thousands of kilometers of stream bank to be hardened without ever performing one. The Corps is now on the Yellowstone River under court order to conduct a cumulative impact assessment for the first time (Herring 1999).

Public ownership and ecological stewardship

In dozens of instances, state governments and private parties have relied upon public ownership and the public trust doctrine to enforce public title to floodplain, to prevent trespass on public lands, and to protect ecological integrity. The tasks ahead are to build upon such successes: first, to formulate, win public support for, and broadly apply a comprehensive strategy to find and claim public streambeds and floodplains, and, second, to manage these to preserve and recover fluvial process function, habitat, and the myriad derivative benefits.

Programs to find public streambeds can be modeled upon South Carolina's comprehensive and substantially complete navigable streams inventory, upon Arizona's methodology for locating all of its navigable streams, and upon Mississippi's statutorily mandated mapping of publicly owned tidelands,

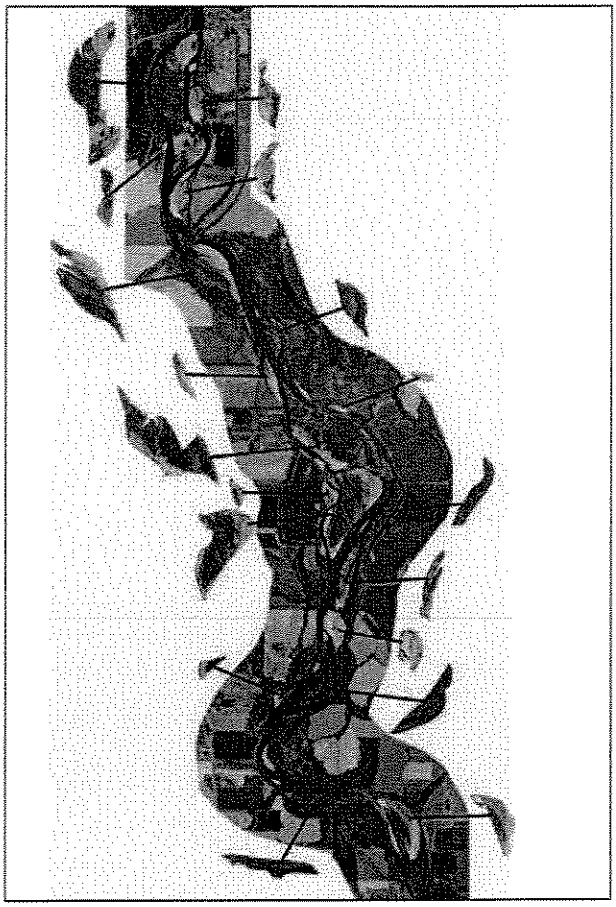

Figure 3. We analyzed a 12-kilometer section of the Willamette River, Oregon, shown here in a 1998 aerial photograph (river kilometers 259–271). To estimate an average island formation rate, we used sequential aerial photographs taken at approximately 10-year intervals to identify landforms existing in the 1998 photograph, whose genesis can be traced to a within-channel bar emerging sometime between 1959 and 1998. Each of the 18 landforms fitting this criterion is pictured along the photograph's edge. Flow is upward on the page. Base photograph: WAC Corporation, Eugene, Oregon.

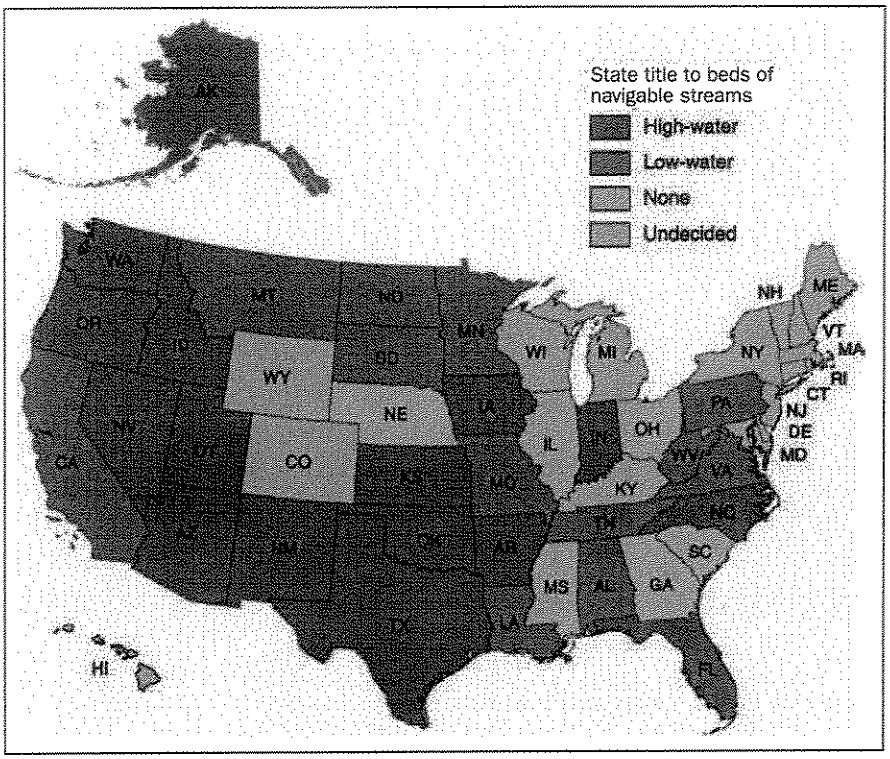

Figure 4. Status of title to beds beneath navigable streams in the 50 states (supporting citations are available from the authors).

which include estuaries (State of Arizona 2001, State of South Carolina 2002; Mississippi Code Annotated, § 29-15-7[1] [1989]). Mississippi sets a valuable precedent by making available GIS (geographic information system) maps that show the boundaries of these trust resources.

Floodplain originating as midchannel islands can be distinguished in readily accessible time-series aerial photographic surveys, which have been flown over many streams since about 1930. It also can be discerned from characteristic patterns of vegetation, relict geomorphic elements, and soil profiles (*Missouri v. Kentucky,* 78 U.S. 395 [1870]). No state systematically tracks public floodplain, though numerous states have identified and claimed some.

States can be compelled to locate public trust resources. Arizona's program to identify all navigable streams was ordered by the courts after public interest advocates successfully challenged a legislative attempt to give away all of the state's streambed (*Defenders of Wildlife v. Hull,* 18 P.3d 772 [2001]). As public streams and floodplain are inventoried, legal interests (e.g., bare title, leases, permits) can be ascertained, encroachments (e.g., riprap, flow deflectors) catalogued, and areas of greater geomorphic activity—existing or potential—noted.

States can strengthen enforcement of public ownership rights, with emphasis upon protecting and restoring fluvial geomorphic processes. Recently formed islands present a particularly rich opportunity. Landforms and bedforms associated with these provide critical habitats (e.g., spawning ground and nursery for fish and initial establishment surfaces for riparian forest), and myriad other habitat types evolve from them (Merigliano 1996, Van Steeter and Pitlick 1998, Dykaar and Wigington 2000). Purchase or establishment of conservation easements over streamfront property typically costs thousands of dollars per hectare and may entail thousands more per hectare for rehabilitation. Here, however, as numerous states have already proven, there is no need for compensation, willing sellers, or eminent domain proceedings because the land is public property.

On streambed (to the ordinary high-water line), the public trust doctrine can be used to limit emplacement of hard structures, even where bare title has been conveyed, because these structures interfere with fluvial geomorphic processes on which enjoyment of public ownership interests (e.g., fisheries) depends. Where states hold title, Mississippi's Public Trust Tidelands Program is a potential model (State of Mississippi 2002). This enabling legislation states, "It is declared to be the public policy of this state to favor the preservation of the natural state of the public trust tidelands and their ecosystems and to prevent the despoliation and destruction of them, except where a specific alteration of specific public trust tidelands would serve a higher public interest in compliance with the public purposes of the public trust in which such tidelands are held" (Mississippi Code Annotated, § 29-15-3[1] [1989]; Duff and Fletcher 1998). Mississippi secures a substantial portion of coastal marshes within a coastal preserves program and leases trust lands to generate about $5 million per year to steward and augment preserves.

Reclaiming floodplain formed since statehood and already quitclaimed, conveyed to, or occupied by others; removing bank armor and other structures; enforcing public rights to aesthetic quality and other interests more recently recognized; and preventing abasement of public streambeds and floodplains resulting from alterations to connected tributaries, wetlands, and uplands are additional actions based upon public ownership that can be used to further ecological stewardship goals. Each has its own obstacles to realization, which vary from state to state, but each also has legal and scientific basis. None raises the constitutional issue of compensation for property taken for public purposes, because all entail enforcement of property rights that are already vested in the public.

If state governments pursue strategies outlined in this article, owners and occupants of watersheds throughout the nation, from headwaters to outflows, may be subjected to

additional oversight and limitation. These potentially sweeping consequences of public ownership—especially of large islands and former islands yet to be claimed in the public's name—give tremendous power to those seeking to protect against further ecological degradation and to recoup losses. Where negotiation fails, a variety of legal actions to enforce public rights can be brought by public officials and—where trust beneficiaries have standing to sue—by private parties.

Conclusion

Despite growing expenditures for restoration and regulation, US stream–floodplain systems continue their overall decline. Public ownership, the public trust doctrine, and knowledge about how fluvial geomorphic processes enable these ecosystems to generate value afford sound and grossly underutilized legal and scientific bases for more successful stewardship.

Acknowledgments

We gratefully acknowledge Virginia Dykaar for contributions to all aspects of this work; Robin Bayer, Tommy Butler, Susan George, Linden Hagans, Jeffery Hook, Hilary Hug, Kerry Kehoe, Donald Kennedy, Brian Schmidt, Michael Smith, Margot Zallen, and three anonymous reviewers for reading, encouraging, and advising; and more than 100 state attorneys general, state land managers, and other state agency personnel around the nation for helping us navigate, using their knowledge of their own localities and specialties, the labyrinth of public trust law.

References cited

[BPA] Bonneville Power Administration. 2002. Fish and wildlife group, fiscal information. (26 February 2003; *www.efw.bpa.gov/cgi-bin/FW/Fiscal.cgi)*

Bravard J, Amoros C, Pautou G. 1986. Impact of civil engineering works on the successions of communities in a fluvial system. Oikos 47: 92–111.

Duff JA, Fletcher KM. 1998. Augmenting the public trust: The secretary of state's efforts to create a public trust ecosystem regime in Mississippi. Mississippi Law Journal 67: 645–694.

Dykaar BB, Wigington PJ Jr. 2000. Floodplain formation and cottonwood colonization patterns on the Willamette River, Oregon, USA. Environmental Management 25: 87–104.

Federal Caucus. 1999. Conservation of Columbia Basin fish: Building a conceptual recovery plan ("All-H Paper"). (15 February 2003; *www.salmonrecovery.gov/Dec_1999_Draft_Strategy_documents.shtml)*

Herring H. 1999. Strangling the last best river. High Country News, 12 April. (15 February 2003; *www.hcn.org/servlets/hcn.Article?article_id=4931)*

Hooke JM. 1986. The significance of mid-channel bars in an active meandering river. Sedimentology 33: 839–850.

Huggenberger P, Hoehn E, Beschta R, Woessner W. 1998. Abiotic aspects of channels and floodplains in riparian ecology. Freshwater Biology 40: 407–425.

Lewin J. 1976. Initiation of bed forms and meanders in coarse-grained sediment. Geological Society of America Bulletin 87: 281–285.

Ligon FK, Dietrich WE, Trush WJ. 1995. Downstream ecological effects of dams. BioScience 45: 183–192.

Marvel CC. 1957. Annotation: Applicability of rules of accretion and reliction so as to confer upon owner of island or bar in navigable stream title to additions. American Law Reports 54: 643–655.

Merigliano MF. 1996. Ecology and Management of the South Fork Snake River Cottonwood Forest. Boise (ID): US Department of the Interior, Bureau of Land Management, Idaho state office. Technical Bulletin 96-9.

Norman DK, Cederholm CJ, Lingley WS Jr. 1998. Flood plains, salmon habitat, and sand and gravel mining. Washington Geology 26: 3–20.

Rood SB, Mahoney JM. 1990. Collapse of riparian poplar forests downstream from dams in western prairies: Probable causes and prospects for mitigation. Environmental Management 14: 451–464.

Sax JL. 1970. The public trust doctrine in natural resource law: Effective judicial intervention. Michigan Law Review 68: 471–566.

Slade DC, Kehoe RK, Stahl JK. 1997. Putting the Public Trust Doctrine to Work. 2nd ed. Washington (DC): Coastal States Organization.

State of Arizona. 2001. Streambed Program. Phoenix: State of Arizona State Land Department.

State of Indiana. 2002. Roster of Indiana waters declared navigable or nonnavigable. Indianapolis: State of Indiana Natural Resources Commission. (15 February 2003; *www.in.gov/nrc/policy/III.html)*

State of Mississippi. 2002. Administrative rules: Control and leasing of public trust tidelands. Jackson: State of Mississippi Secretary of State, Public Lands Division. (15 February 2003; *www.sos.state.ms.us/PublicLands/Tidelands/table.asp)*

State of Montana. 1997. Policy for Licensing Structures in, Over, Below or Above Navigable Waterways. Helena: State of Montana Department of Natural Resources and Conservation, Special Uses Management Bureau. Memo SUMB 97-1-1.

State of South Carolina. 2002. Construction in navigable waters. Columbia: State of South Carolina Department of Health and Environmental Control. (15 February 2003; *www.scdhec.net/water/html/navwater.html)*

Van Steeter MM, Pitlick J. 1998. Geomorphology and endangered fish habitats of the upper Colorado River, 1: Historic changes in streamflow, sediment load, and channel morphology. Water Resources Research 34: 287–302.

Williams RN, et al. 1999. Scientific issues in the restoration of salmonid fishes in the Columbia River. Fisheries 24: 10–19.