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DRAFT November 21, 1994

Ref: 8WM-WQ

Mr. John Brink
Environmental Protection Agency
999 18th Street, Suite 500
Denver, Colorado 80202-2466

Dear Mr. Brink:

The purpose of this letter is to briefly summarize our meeting with Jack Schwabacher at your office on November 7, 1994, which discussed my letter of the same date. I must say that I was disappointed that more progress was not made. Nevertheless, substantial progress was made in at least two areas: (1) we agreed that the project is in compliance with the requirements of 40 C.F.R. Section 230.10(b) regarding State water quality standards, toxic effluents, and endangered species, and (2) we agreed that the project is in compliance with 40 C.F.R. Section 230.10(c) which states that no discharge will be permitted that "will cause or contribute to significant degradation of the waters of the United States."

Unfortunately, we could not arrive at an agreement regarding three primary items: (1) project purposes, (2) compliance with 40 C.F.R. Section 230.10(a) regarding alternative analyses, and (3) compliance with the avoid and minimize provisions of 40 C.F.R. Section 210.10(d).

Regarding project purposes, you held that the "basic" project purpose should be "enhancement of fisheries." Jack and I, however, felt that this wording was too vague and failed to capture the essence of Jack's original intention, which was simply to produce a worthwhile place to go fishing. This disagreement is not trivial, since the analysis of alternatives must be conducted in light of project purposes.

Furthermore, I am still confused about the distinction between the "basic purpose," and "overall project purposes." The relevant sentence in the Guidelines that discusses the "basic purpose" [40 C.F.R. Section 230.10(a)(3)] is as follows:

> "(3) Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in subpart E) does not require access or

> proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not 'water-dependent'), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise." (emphasis added)

The relevant sentence in the Guidelines that discusses "overall project purposes" [40 C.F.R. Section 230.10(a)(2)] is as follows:

> "(2) An alternative is practicable if it is available and capable of being done after taking into consideration cost existing technology, and logistics in light of overall project purposes." (emphasis added)

Thus it seems that it was the intention of authors of the Guidelines that the alternatives analysis should take place in two phases: (1) an alternatives analysis to determine water-dependency that is apparently undertaken only light of the basic project purpose, and (2) given that a project is water-dependent (i.e. it requires "access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose), an alternatives analysis to determine in detail exactly where and how to install the project that may be undertaken "in light of overall project purposes."

In my letter of November 7, I clearly demonstrated that the project is water-dependent by discussing the futility of the only conceivable, logical alternative, namely, to construct an upland pond fed by pumped groundwater. (One other problem with this approach, that I did not mention in my letter of November 7, is the question of whether such a well would lower the water table to the point where the perennial springs would slow or dry up, which could have catastrophic effects for the local "waters of the Nation.") Any other conceivable project would require some sort of "access or proximity to or siting within the special aquatic site in question." We are, therefore, in disagreement over your assessment that considerations from the standpoint of stock watering and waterfowl habitat should not be taken into account when determining the exact configuration of the pond, since the project, from the standpoint of "overall project purposes," is a true, functionally integrated, multiple purpose project, as I took great pains to document in my letter of November 7.

Regarding the actual alternatives analysis that I performed in my letter of November 7, we are in disagreement over two primary items: (1) the geographical scope of the alternatives analysis, and (2) the level of documentation that should be included in the alternatives analysis.

At our meeting of November 7, you suggested that the geographical scope of the alternatives analysis be extended to include Jack's Green River parcel (which is not directly owned by Jack, but is held in trust). I say "extended" because this is the first time that Jack or I have heard of such a suggestion. There is certainly no documentation in my file that the alternatives analysis should include the Green River parcel, and you evidently did not mention this possibility when you visited the project site.

You stated that we should include the Green River parcel because any financial benefits that could be derived from the Green River parcel are transferrable to the parcel containing the two Miller sections where the pond is currently sited. However, this proposition reflects a misunderstanding of how western ranches operate.

A western ranch is analogous to an international conglomerate, in that each type of corporation is divided into several elements, each of which must contribute to the profitability of the whole. The advantage of such a division into several elements is that any risk associated with any particular element is spread out among the whole corporation. However, no element can remain in a chronically unprofitable status for very long. Such elements will eventually have to be turned around or liquidated. Consequently, a project that would "enhance fisheries" on the Green River parcel would have no long-term benefit for the east parcel. This, in turn, increases the likelihood that the east parcel will eventually be sold and subdivided. Since it was clearly Jack's intention to increase the productivity of the east parcel, Jack and I believe that alternatives sited on the Green River parcel are not practicable.

Regarding the level of documentation of the alternatives analysis, in my November 7 letter I discussed several possible alternatives to the present pond, including (1) the alternative of no action, (2) habitat improvements to the spring creek, itself, including log-drop structures and excavation of holes in the creek, (3) an upland pond fed by well water, (4) an upland pond fed by diverting water from the spring creek, (5) damming one of the springs at its source, (6) siting the pond somewhere else along the spring creek, and (7) constructing a smaller pond on the same site. However, you did not feel this was sufficient to comply with the requirements of 40 C.F.R. 230.10(a) regarding alternatives analysis.

For the first time in this process, you suggested the level of documentation that you would like to see in the alternatives analysis. In particular, you stated that you would like to see a complete design, job cost accounting, and impact analysis for perhaps ten hypothetical projects at specific locations. Among possible data that could be collected, you suggested an exact estimate of the number of acres of wetland that would be flooded or dried in each hypothetical alternative, sediment transport studies in the spring creek, and computer modeling to predict trout production for each hypothetical alternative. Since this list is probably not exhaustive, other data that could be collected include a hydrology study to determine the effects of groundwater pumping on the local springs, a survey and deliniation of all waters on Quarter Circle 5 Ranches, and a public opinion survey of Sublette County anglers in order to determine their willingness to pay for each of the hypothetical alternatives.

Quarter Circle 5 Ranches would be willing to provide a more detailed alternatives analysis, but only if such a detailed analysis is relevant and necessary under the law and comparable to similar projects involving western ranches. The Guidelines (40 C.F.R. 230.6) are quite explicit that the level of documentation should be proportional to the "significance and complexity" of the project:

> "(a) The manner in which these Guidelines are used depends on the physical, biological, and chemical nature of the proposed extraction site, the material to be discharged, and the candidate disposal site, including any other important components of the ecosystem being evaluated. Documentation to demonstrate knowledge about the extraction site, materials to be extracted, and the candidate disposal site is an essential component of guideline application. These Guidelines allow evaluation and documentation for a variety of activities, ranging from those with large, complex impacts on the aquatic environment to those for which the impact is likely to be innocuous. ... It is anticipated that substantial numbers of permit applications will be for minor, routine activities that have little, if any, potential for significant degradation of the aquatic environment. It generally is not intended or expected that extensive testing, evaluation or analysis will be needed to make findings of compliance in such routine cases. ...
>
> "(b) The Guidelines user, including the agency or agencies responsible for implementing the Guidelines, must recognize the different levels of effort that should be associated with varying degrees of impact and require or prepare commensurate documentation. The level of documentation should reflect the significance and complexity of the discharge activity.
>
> "(c) An essential part of the evaluation process involves making determinations as to the relevance of

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any portion(s) of the Guidelines and conducting further evaluation only as needed. ..." (my emphasis)

Clearly, it was the intention of Congress that the Clean Water Act was meant to prevent harm to the aquatic ecosystem, particularly irreversible harm [40 C.F.R. 230.1(d)]. However, the trout pond on Jack's ranch is not in the same sort of category of land use as, for example, a project that proposes filling of wetlands to make room for a new shopping center. Indeed, practically everyone involved in this project so far has acknowledged that the project, by its intrinsic nature, will be of benefit to the aquatic ecosystem, or at the very least, that the project involves a tradeoff of natural values involving no net cost to the aquatic ecosystem. This is simply because the project, itself, was conceived from the start to be a habitat enhancement. Note that I am not discussing mitigation. Mitigation is meant only to offset projects with negative impacts, whereas this project--without any attempted mitigation--is beneficial to the aquatic ecosystem.

"Aquatic ecosystem" is defined in 40 C.F.R. 230.3(c):

> "(c) The terms aquatic environment and aquatic ecosystem mean waters of the United States, including wetlands, that serve as habitat for interrelated and interacting communities and populations of plants and animals." (original emphasis)

Since it was the original intention of Congress to protect and preserve the health of such ecosystems, it is interesting to read what scientific experts have written on the subject. The Journal Aquatic Ecosystem Health is a good place to start. David J. Rapport (1992, JAEH 1: 15-24) reviewed several case studies of ecosystem level response to cultural stress. From these he was able to identify a common set of symptoms that characterize what he termed 'ecosystem distress syndrome:'

> "(1) alteration in biotic community structure to favor smaller forms, (2) reduced species diversity, (3) increased dominance by 'r' selected species, (4) increased dominance by exotic species, (5) shortened food-chain length, (6) increased disease prevalence, and (7) reduced population stability." (p. 19)

Thus we may ask how the Schwabacher pond fares against this list.

(1) Alteration in biotic community structure to favor smaller forms: The Schwabacher pond will only increase the proportion of larger forms since the pond results in a major habitat improvement for larger vertebrates such as trout, aquatic mammals, waterfowl, and certain raptors such as the osprey, and even certain endangered species. For example, in a study of

habitat use by whooping cranes (Marshall A. Howe, 1989, USFWS Technical Report 21, Figure 2), these large birds mostly used palustrine (about 80%) and lacustrine (about 15%) wetland systems for both roosting and feeding, whereas riverine and other types of wetlands barely accounted for 5% of total wetland use.

(2) Reduced species diversity: The Schwabacher pond will increase local species diversity by increasing habitat diversity (see Robert J. Behnke's affidavit). Moreover, the pond enhances the mix of habitat for those species that may use both the short-grass riparian zone and the flooded marshes. To take the example of whooping cranes once again, Howe's study (p. 9) found that "feeding and roosting sites were typically (56%, N=73) less than 1km apart." This is not surprising, since it is a straight-forward prediction of optimal foraging theory that organisms will seek to minimize the distance between resting and feeding sites. Thus the pond actually enhances the value of the adjacent riparian zones as feeding sites for whooping cranes.

(3) Increased dominance by 'r' selected species: Since the pond will actually help to stabilize the ecosystem, both locally and downstream by providing a means to store spring runoff (see Quentin Skinner's affidavit), then it is highly unlikely that the pond will cause 'r' selected species (which prefer highly disturbed regimes) to predominate.

(4) Increased dominance by exotic species: Since most of the increased species diversity will come from the natural dispersal of the mostly native species pool (e.g. waterfowl, macro-invertebrates, and so on), the pond will not cause increased dominance by exotic species. In addition, the dam will serve as an excellent fish barrier to upstream movement by exotic fish species. This allows the possibility that the watershed upstream from the dam may be reclaimed from the non-native brook trout and allow re-stocking with native Colorado River cutthroat trout (see Robert J. Behnke's affidavit).

(5) Shortened food-chain length: By increasing the number of larger vertebrates that will use the project site, the local food-chain length is actually increased. For example, at least one osprey has been observed using the pond to hunt for trout (Jack Schwabacher, personal communication).

(6) Increased disease prevalence: There is no reason to think that the pond will increase disease prevalence.

(7) Reduced population stability: As stated in Quentin Skinner's affidavit, the pond offers a tool to help stabilize the local aquatic ecosystem. Of course, a few individual plant organisms were drowned by the pond. This should not be construed as a necessary harm to their parent plant populations, however. For example, few would argue that a certain amount of hunting of

individual deer is necessarily harmful to the parent deer population. To equate any death of individuals as harmful to their parent populations is to misunderstand the nature of biological populations. As Ernst Mayr, the most respected evolutionary biologist alive today, has written (Toward a New Philosophy of Biology, 1988):

> A human without his head, his heart, his parathyroid, his liver, and various other organs is unable to live. Even the removal of less vital organs, like the eyes, an arm a leg, the stomach, or many other parts, seriously alter the individual, converting it into something it was not before. By contrast, a species of a million organisms is not seriously affected if 10,000 or even 100,000 of them should be removed by sudden death. This sort of thing happens in nature periodically as a result of drought, disease, or other catastrophes. The damage is quickly repaired in the ensuing seasons. It is only in the lower invertebrates and in many kinds of plants that a seriously mutilated individual can be restored as quickly as a decimated species." (p. 349, my emphasis)

The flooded riparian plants were but a small part of the larger riparian community consisting of several populations of interbreeding organisms associated with the entire spring creek. No local extinctions of any species were caused by the pond. The same populations of vegetation are recolonizing a comparable area along the margins of the pond. The pond offers a management tool to enhance the stability of the downstream riparian populations of vegetation. Therefore, there is no basis to claim that any plant populations were harmed by the project.

Clearly, the Schwabacher pond will not cause the 'ecosystem distress syndrome' described by Rapport. Having discussed what Science has to say on the matter, let us now consider what the Guidelines have to say regarding harm to aquatic ecosystems.

Subpart C--Potential impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem

230.20 Substrate: This subparagraph is primarily concerned to avoid changes the in physical substrate of a site that result from discharges fill material that are different from the material originally present at the disposal site. Since the dam was constructed of material taken from a borrow pit in the pond, itself, no foreign fill material was imported to the site. Therefore, the pond did not cause any significant changes to the physical substrate of the site.

230.21 Suspended particulates/turbidity: This subparagraph is primarily concerned to avoid the adverse effects of elevated levels of suspended particulates in the water column. However, the pond will not increase the level of suspended particulates, but will, if anything, increase the level of clarity of the water column.

230.22 Water: This subparagraph is primarily concerned to avoid changes in water qualities, such as clarity, color, odor, taste, or the addition of contaminants that render the water unsuitable for populations of aquatic organisms, and for human consumption, recreation, or aesthetics. However, the pond will have no negative effects on water quality.

230.23 Current patterns and water circulation: This subparagraph is primarily concerned to avoid adverse changes in aquatic community structure, and erosion rates that result from changes in water circulation patterns. Certainly, the dam caused changes in the current pattern of the spring creek. As described above, however, the pond will actually enhance the biodiversity and connectivity of the aquatic ecosystem. In addition, the pond will slow the flow of nutrients out of the system, thus increasing the local productivity of the project site. Furthermore, the pond will not increase erosion, but will help to reduce it. Therefore, though the pond will alter the local water circulation pattern, these changes will actually have <u>beneficial</u> effects from the standpoint of aquatic community structure and erosion rates.

230.24 Normal water fluctuations: This subparagraph is primarily concerned to avoid the loss of environmental values caused by radical changes in the flow regime. However, the pond is equipped with an overflow channel. Since the pond water level will be held relatively constant, spring flood flows will be conveyed back to the spring creek via the overflow channel. Therefore, the flow regime of the spring creek will not be markedly affected by the pond (see Quentin Skinner's affidavit).

230.25 Salinity gradients: This subparagraph is primarily concerned to avoid adverse effects in the zone where salt water from the ocean mixes with fresh water from land. Since Wyoming is a land-locked state, the project will have no adverse effects on salinity gradients.

Subpart D--Potential Impacts on Biological Characteristics of the Aquatic Ecosystem.

230.30 Threatened and Endangered Species: This subparagraph is primarily concerned to avoid negative impacts on endangered species. As stated in my letter of November 7, the pond will cause a certain amount of evaporative water loss, that could have an incrementally negative effect on endangered fish species of the Colorado/Green River system. However, payment of an "offset jeopardy fee" is considered by the U.S. Fish and Wildlife Service to be a reasonable and prudent alternative to offset the likelihood of jeopardy for these fishes. The pond will harm no other threatened or endangered species, but should be a plus to endangered whooping cranes. The pond offers an additional site to reestablish Category 2 Colorado River cutthroat trout, as well.

230.31 Fish, crustaceans, mollusks, and other aquatic organisms in the food web: This subparagraph is primarily concerned to avoid negative impacts to populations of these kinds of organisms. As stated above, the pond will increase the habitat diversity of the aquatic ecosystem, and thus the diversity of these organisms. In addition, the slowing of nutrient flow out of the system will increase the overall productivity of the ecosystem. The benefits of the pond are already evidenced by the rapid growth of individual brook trout that inhabit the pond. These fish are at the top of the local trophic pyramid. The rapid growth of these fish are, therefore, prima facie evidence that the supporting populations of invertebrates are also being benefitted by the pond.

230.32 Other wildlife: This subparagraph is primarily concerned to avoid negative impacts on other wildlife, especially non-fish vertebrates, that are associated with aquatic ecosystems. However, the pond is of benefit to such vertebrates, particularly waterfowl, as evidenced by increased use of the project site by these birds (personal observation).

Subpart E--Potential Impacts to Special Aquatic Sites.

According to 40 C.F.R. 230.3(q-1), special aquatic sites possess "special ecological characteristics ... These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region."

230.40 Sanctuaries and refuges: This subparagraph is primarily concerned to avoid negative impacts on areas designated by government to be managed principally for the preservation and use of fish and wildlife resources. Since the pond is on a private land, the pond will have no effect on designated refuges. However, the pond will enhance many of the natural values such refuges are designed to protect.

230.41 Wetlands: This subparagraph is primarily concerned to avoid adverse impacts to wetlands. The pond is estimated to have permanently flooded some eleven acres of riparian short-grass wet meadow associated with the spring creek. (Note that this number is based on analysis of aerial photographs that have never been ground-truthed.) However, as stated above, this impact will cause no permanent harm to the actual populations of plants, of which only a relatively small proportion were flooded. Moreover, this loss will have no incremental negative effect on the regional ecosystem of Sublette County, since the amount of short grass wet meadows are artificially inflated due to the large number of irrigated hay meadows widespread throughout Sublette County. As stated above, the pond will actually increase the value of the adjacent riparian wetlands to those species that can use both types of habitats (e.g. whooping cranes). As stated in Quentin Skinner's affidavit, the pond serves as an additional management tool to preserve the stability of the downstream riparian zone. In addition, though the pond flooded perhaps eleven acres of wetland, the pond also resulted in the creation of a comparable amount of palustrine and lacustrine wetlands associated with the margins of the pond. (Again note that this is not project mitigation, but simply the desired effect of the basic and overall project purposes.) Finally, as noted in the definition of "special aquatic sites," these sites are important not so much because of their intrinsic value, but for their significant positive contribution "to the general overall environmental health or vitality of the entire ecosystem of a region." As I argued above, however, the spring creek plus pond will have a higher connectivity--and therefore more of a positive significant contribution--to the surrounding ecosystem than will the spring creek alone. Thus, though the pond results in the flooding of a certain amount of wetland, the positive attributes and the additional wetlands created by the pond result in a trade-off of natural values that can hardly be interpreted as a harm to the aquatic ecosystem. Admittedly, however, such arguments will only make sense within a conceptual system flexible enough to distinguish between the consequences of a trout pond and a similarly sized shopping center on the surrounding ecosystem.

230.42 Mud flats: This subparagraph is primarily concerned to avoid negative impacts on mud flats and their associated biota. However, the pond impacted no mud flats.

230.43 Vegetated shallows: This subparagraph is primarily concerned to avoid negative impacts to permanently inundated areas that support communities of rooted aquatic vegetation. The pond flooded no such areas, but did create such areas where none existed before.

230.44 Coral reefs: This subparagraph is primarily concerned to avoid negative impacts to coral reefs and their associated communities. Obviously, the pond will have no effect on these special aquatic sites.

230.45 Riffle and pool complexes: This subparagraph is primarily concerned to avoid negative impacts to steep gradient sections of streams characterized by riffle and pool complexes (type "A" and "B" rivers in Rosgen's classification). However, contra your letter of June 15 (p. 2), the pond will impact no such special aquatic sites. The spring creek is a low gradient meandering stream (type "C" in Rosgen's classification) rather than a riffle and pool complex (see affidavit by Dr. Skinner, and Dr. Behnke's comments included in my letter of November 7).

Subpart F--Potential Effects on Human Use Characteristics

230.50 Municipal and private water supplies: This subparagraph is primarily concerned to avoid negative impacts on water quality that renders water unpalatable or unhealthy by the addition of suspended particulates, viruses and pathogenic organisms, and dissolved materials. However, the pond will have no such effect on water quality since it will not result in the addition of the above mentioned contaminants or any other contaminant.

230.51 Recreational and commercial fisheries: This subparagraph is primarily concerned to avoid negative effects on recreational or commercial fishing grounds that serve as habitat for consumable aquatic organisms. Since the pond was constructed in order to provide a worthwhile place to go fishing, fishery values have only been enhanced by the project, as evidenced by the rapid growth of brook trout already observed.

230.52 Water-related recreation: This subparagraph is primarily concerned to avoid adverse effects on activities associated with aquatic ecosystems that are undertaken for amusement and relaxation. As stated above, however, the pond was constructed expressly in order to enhance such recreational values, including fishing and wildlife viewing (especially including waterfowl). Moreover, Jack has made the pond available to local recreational groups such as the Boy Scouts of America and Ducks Unlimited.

230.53 Aesthetics: This subparagraph is primarily concerned to avoid loss of the aesthetic values associated with aquatic ecosystems. These values consist of a perception of beauty by one or a combination of the senses of sight, hearing, touch, and smell. Aesthetics of aquatic systems apply to the quality of life enjoyed by the public and property owners. In particular, loss of aesthetic values can lower property values. However, the pond enhances the overall aesthetics of the project site, by enhancing the diversity of the area, bringing in more wildlife. These enhancements are reflected in an increase in the appraised value of the project site (Lonnie Elliott, appraiser, personal communication).

230.54 Parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves: This subparagraph is primarily concerned to avoid harm to areas designated by government to be managed for their aesthetic, educational, historical, or scientific values. Though the pond is not in such a designated area, the project still seeks to preserve and enhance these values.

To return to the requirements of 40 C.F.R. 320.6 concerning the level of documentation, it is abundantly clear that the "significance" of the project is that it will be an overall benefit to the aquatic ecosystem, whether one considers pertinent scientific literature or the Guidelines, without any mitigation. The essence of the Guidelines is the presumption that projects impacting special aquatic sites are harmful to the aquatic ecosystem. However, a presumption is not an assertion of Objective Truth; a presumption is simply an hypothesis that is given an initially privileged position, but that is open to refutation, just as any other hypothesis is. In other words, the burden of proof is on the applicant to show that the project will not harm the ecosystem. In this letter, I have documented that the project will not harm the aquatic ecosystem. This is not a surprising finding, given that it was Jack's intention to enhance the local habitat.

Quarter Circle 5 Ranches has provided written documentation in order to comply with the requirements outlined in 40 C.F.R. 230.10. Given that the project does not harm the aquatic ecosystem, however, in light of the provisions of 40 C.F.R. 230.6, I question the relevance and necessity of providing additional documentation, at least to the extent suggested by you at our meeting of November 7.

In addition, since the pond, by its purposes and design and concrete effects, is of benefit to the aquatic ecosystem, the avoid and minimize provisions of 40 C.F.R. 230.10(d) are irrelevant since there is no "harm" to avoid and minimize.

This finally brings me to the last point that I wish to cover in this letter. Quarter Circle 5 Ranches has acted in good faith to cooperate with the federal agencies involved in this project. However, this cooperation is probably gratuitous, since it is debatable whether a 404 permit is even required in this situation. According to section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344), from which the Guidelines derive their authority, normal farming and ranching practices are not to be subject to regulation under this section:

> "(1) Except as provided in paragraph (2) of this subsection, the discharge of dredged or fill material--
>
> "(A) from normal farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices;
>
> "(B) for the purpose of maintenance, including emergency reconstruction of recently damaged parts, of currently serviceable structures such as dikes, dams

> levees, groins, riprap, breakwaters, causeways, and bridge abutments or approaches, and transportation structures;
>
> "(C) for the purpose of construction or maintenance of farm or stock ponds or irrigation ditches, or the maintenance of drainage ditches ...
>
> "is not prohibited by or otherwise subject to regulation under this section or section 1311(a) or 1342 of this title (except for effluent standards or prohibitions under section 1317 of this title)." [33 U.S.C. 1344(f), p. 1069]

As I stated in my letter of November 7, modern ranchers who are successful must utilize all ranch resources capable of producing income. Such "holistic" approaches to ranch management are now being taught at universities and written about in the mainstream range management literature. Consequently, such management techniques now constitute "normal farming activities." It is clear from the wording of subparagraph 1344(f)(A) that the list "planting, seeding ..." and so on is not to be construed as exhaustive. Second, the choice of the phrase "minor drainage," however, indicates that there are limits to what is allowed under this subparagraph. Therefore, a reasonable and prudent interpretation of this subparagraph would allow income generating enterprises on ranches so long as the impacts to the aquatic ecosystem are "minor." Consequently, those income generating enterprises that are <u>beneficial</u> to the aquatic environment would presumably not require a 404 permit. To proceed with an enforcement action against such a project could be legally construed as an arbitrary 'taking' of private property rights as well as a violation of the Clean Water Act.

Regarding subparagraph 1344(f)(B) concerning maintenance of dikes, dams, and so forth, it should be noted that the current pond is the result of a repair to a structure originally constructed in 1972. That the repair took eighteen years to complete is irrelevant. Though the subparagraph mentions "emergency reconstruction," it is clear from the wording that repairs need not be limited to emergency situations. No mention is made of any 'statute of limitations.' Consequently, to proceed with an enforcement action against the project would be an arbitrary limitation on the right to repair structures granted by the Clean Water Act.

Finally, regarding subparagraph 1344(f)(C) concerning farm and stock ponds, Congress makes explicit its intention that the Clean Water Act should not interfere with the construction of such ponds. This is not surprising, since such ponds are usually beneficial to the aquatic environment, in contrast to most other cultural impacts. Note that no mention is made regarding the size of such ponds. However, the construction of farm ponds to be used for both fishing and stock watering is a decades old practice. Such ponds are part of "normal farming and ranching activities." Consequently, it is reasonable and prudent to interpret this subparagraph as allowing ponds larger than the minimum size absolutely necessary for stock watering purposes. Hence, the Schwabacher pond may be legally construed as a "farm pond," thereby obviating the need for a 404 permit.

To summarize this letter, in my considered opinion, Quarter Circle 5 Ranches is in full compliance with the requirements of the Clean Water Act and should be permitted as is. In my letter of November 7, I submitted documentation to demonstrate compliance with the provisions of 40 C.F.R. 230.10, including an alternatives analysis that considered seven possible alternatives to the Schwabacher pond. In this letter I have submitted documentation that the pond has not caused any significant harm to the aquatic ecosystem, in light of the provisions of Subparts C through F of the Guidelines, and pertinent scientific literature. The Guidelines [40 C.F.R. 230.6] clearly state that the level of documentation provided by the applicant should be proportional to the "significance" of the project. Documentation provided in this letter, and by Dr. Behnke, Dr. Skinner, and others clearly show that the "significance" of the Schwabacher pond is that it is innocuous. Consequently, I am opposed to providing a more detailed alternatives analysis unless the Corps and the EPA can demonstrate, in writing, that: (1) the pond should not be considered a farm pond not subject to regulation under section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344), from which the Guidelines derive their authority, (2) the Corps and the EPA can clearly refute the arguments made by myself, Dr. Behnke, Dr. Skinner, and others that counter the presumption of harm to the aquatic ecosystem [40 C.F.R. 230.10(a)(3)], and (3) the Schwabacher project is not being 'singled out,' in comparison to similar projects on western ranches.

In regard to this last item, I request that all documentation possessed by the Corps and the EPA pertaining to the Schwabacher pond, all other permit applications for fish ponds on ranches in Wyoming since 1985, and any other documentation pertaining to Jack Schwabacher be made available to me for the purpose of reproduction, as per the requirements 33 U.S.C. 1344(o) regarding public availability of permits and permit applications and the Freedom of Information Act.

It is my hope that this letter will give you a better understanding of the position of myself and Quarter Circle 5 Ranches regarding the permit process thus far, which will help us to make better use of our time at our next meeting in Cheyenne.

Sincerely,

Warren J. Platts

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cc: Jack Schwabacher
    Manuel Barnes

REGULATED RIVERS: RESEARCH & MANAGEMENT, VOL. 12, 353–365 (1996)

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WATER ALLOCATION TO PROTECT RIVER ECOSYSTEMS

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ABSTRACT

River regulation has attracted considerable attention over the past 20 years. The effects of (i) changes in the seasonal flow regime below dams and reservoirs and (ii) reduction in flow caused by water abstraction and diversion, upon lotic and riparian ecosystems have been demonstrated for rivers in a range of geographical regions. This paper presents an approach to determining 'ecologically acceptable' flow regimes and volumes. The approach is founded on a set of fundamental scientific principles concerning longitudinal connectivity, vertical exchanges, floodplain flows, channel maintenance flows, minimum flows and optimum flows. The need for a policy for allocating water to protect river ecosystems in England and Wales is discussed and the method is illustrated by a case-study of a chalk stream that has been affected by groundwater abstraction. Sixty per cent of the available resource is shown to be required to sustain the river as a trout stream. Several judgemental decisions are needed in setting an ecologically acceptable flow regime and further research is required to improve our capability for modelling the roles of different flows and patterns of flows in sustaining river ecosystems.

KEY WORDS minimum acceptable flows (MAFs); abstractions; ecological objectives; ecologically acceptable flow regime (EAFR)

INTRODUCTION

In water resources management, the fundamental objectives of river regulation to meet demands for water supply and hydroelectric power have been (i) to create enough storage to control seasonal and between-year variations of flows, and (ii) to minimize the loss of resource by allowing water to run 'unused' to the sea. Dams, reservoirs and interbasin transfers have been constructed to achieve these objectives. Whilst opportunities exist to improve the efficiency of water use (especially through improved irrigation systems, controls of leakage from distribution systems and demand management), river regulation remains a key concept in socio-economic development plans, not least in the dryland areas of the world (Beaumont, 1989; Davies *et al.*, 1994).

The traditional paradigm 'mankind versus nature' focuses on the exploitation of natural resources; the water needs of people are supplied without regard to the needs of natural ecosystems. With increasing concern for the conservation of biodiversity and for the sustainability of environmental systems, the demands of human societies must now be considered in relation to ecological needs. The allocation of water to sustain natural ecosystems, to restore rivers degraded by over-abstraction or inappropriate regulation in the past, and to protect biodiversity for future generations, has become a key issue. At the heart of the problem is the conflict of interests between the needs of the fluvial hydrosystem, which includes not only the lotic system but also the riparian and floodplain systems (Petts and Amoros, 1996), and (i) in-river users requiring unnatural flow patterns, and (ii) abstractions for off-stream users (for domestic, agricultural and industrial purposes). Some progress has been made in addressing the first (e.g. Hesse, 1995). This paper addresses both needs. It examines the context for implementing an 'ecological flow' policy in England and Wales and reviews the principles that should be adopted in determining the allocation of water to meet ecological needs.

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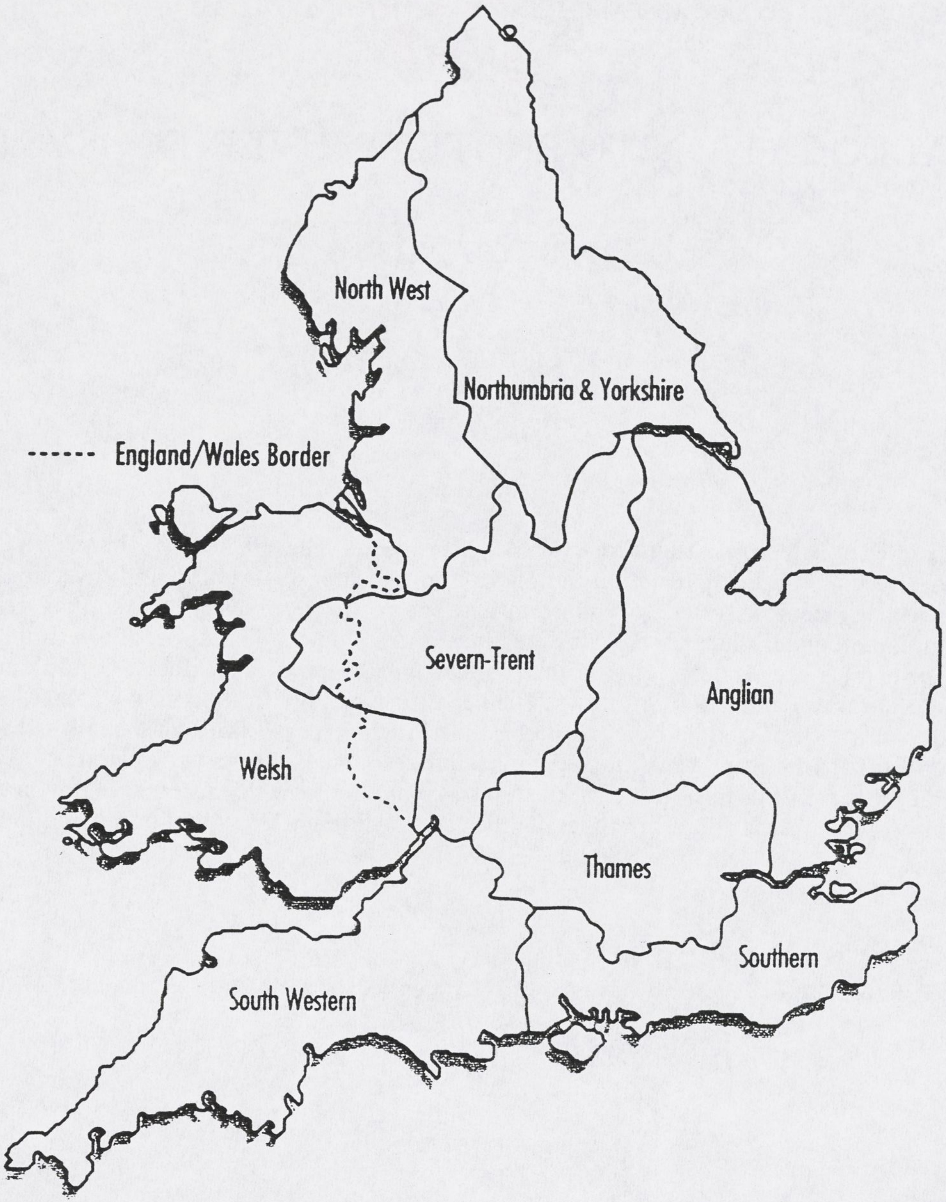

Figure 1. The river management regions of England and Wales as defined by the National River Authority Regions in 1995

AN ECOLOGICAL FLOW POLICY FOR ENGLAND AND WALES

The National Rivers Authority of England and Wales (NRA)* comprises eight regions (Figure 1). Only two of these are based upon large-river catchments (Thames and Severn–Trent) but the boundaries of all regions are defined by watersheds. For the purpose of catchment management planning, England and Wales is divided into 164 medium-sized areas; many being individual catchments (e.g. the basins of the rivers Exe, Test, Welland, Aire, Ribble, Welsh Dee, Warwickshire Avon and Kennet). As 'guardian of the water environment', the NRA aims to manage water resources 'in an environmentally sustainable way, balancing the needs of all users' (NRA, 1994a, p. 2) to achieve a cost-effective balance between the amount of water abstracted from rivers and underground sources, and the amount to be retained to protect the environment

* Replaced by the Environmental Agency for England and Wales from 1 April 1996. The water resource mangement function established by the NRA will continue within the new agency.

Table I. Key components of the National River Authority's approach to river management in England and Wales (from NRA, 1994b)

(i) *Sustainability*—'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' as defined in the 1987 Brundtland Report. The NRA seeks to promote lasting solutions to environmental problems embracing social and economic concerns. The NRA believes the best way to achieve sustainable development is to take an integrated approach to river management, treating a river, together with the land, tributaries and underground water connected with it, as a discrete unit or catchment.

(ii) *Balance*. The NRA seeks to balance the interests of all who benefit from the use of rivers, groundwaters, estuaries and coastal waters, and to balance local (individual catchment) needs with the wider need to ensure the availability of sustainable resources at regional and national levels.

(iii) *Precaution*. Given the limitations of our knowledge particularly about long-term environmental changes, the NRA advocates a precautionary approach to the development of natural resources.

(iv) *Catchment management planning*. This cross-functional objective promotes and integrated approach to pro-active planning in order to prevent future environmental damage. The NRA applies national policy giving due regard to local community needs. All major uses within a catchment—such as abstraction and discharge, recreation and navigation, areas of special conservation interest or flood protection—are considered. Catchment management planning provides a mechanism to target resources to areas where they are most needed.

(v) *Standards and objectives*. The NRA presses for the adoption of policy through statutory objectives and standards. Clear environmental standards and objectives are seen as a pre-requisite for ensuring sustainability. In setting objectives, the NRA takes into account international, national and local (or use-related) objects.

and other in-river and riparian needs. These last include dilution of effluent, flood control and land drainage, navigation, fisheries and recreation and amenity. Five key themes underpin NRA operations (Table I) and each relates to the application of an ecological flow policy.

Flow problems in England and Wales

Water abstraction in England and Wales is dominated by public water supplies (51%) and the power generation industry (36%)—mainly cooling water (NRA, 1994a). Other industry (12%) and spray irrigation and other agriculture (1%) place relatively minor demands on resources; although on a hot summer day in Anglian region irrigation use can exceed public water supply (D. Evans, personal communication). Because of the importance of public water supply abstractions, predictions of future water demands are strongly

Table II. Current water resources (1991 baseline) and average public water supply deficits at demand centre level in 2021 under medium and high demand scenarios (NRA, 1994a)

	Current available yield (Ml/day)	Current demand (Ml/day)	Public water supply deficit in 2021 (Ml/day)		Public water supply deficit in 2021 after local resource options developed (Ml/day)	
			Medium scenario	High scenario	Medium scenario	High scenario
Northumbria area	2046	1106	0	14	0	0
Yorkshire area	1657	1506	29	261	0	0
North-West region	2811	2579	0	164	0	0
Welsh region	1637	1299	38	133	0	0
South-West region	604	499	40	124	0	0
Wessex area	1045	901	58	201	0	84
Severn–Trent region	2724	2411	182	577	4	252
Anglian region	2223	1764	100	195	72	128
Thames Region	4333	3975	270	867	66	629
Southern region	1531	1220	57	152	0	0

influenced by population growth and household size, use per capita (including gardening) and levels of leakage from distribution systems. Demand management and leakage control are key elements in the medium growth scenario (Table II) and are considered by the NRA to be primary elements in an environmentally sustainable water resources strategy. Industrial demands are not expected to increase over the planning period, but demands for spray irrigation are expected to grow significantly, especially in Anglian and Severn–Trent regions, where growth is expected to exceed 50 and 30% of current demands, respectively. The current strategy for many areas is to encourage on-farm, winter-fill storage reservoirs and to restrict direct abstractions from rivers in summer.

In some cases, especially in parts of Anglian, Thames and Southern regions, authorized abstractions from some catchments are already high in relation to the effective rainfall and there is little left for the natural environment. In 1993, the NRA drew up a priority list of 40 rivers perceived as suffering from excessive abstraction (NRA, 1993) and established an alleviation of low flows (ALF) programme. In most cases, the cause of these low flow problems was groundwater abstractions authorized under Licences of Right. Very large numbers of these licences were issued following the introduction of abstraction licensing in the Water Resources Act 1963. The act authorized available abstraction capacity at the time, without regard for environmental needs. However, this Licence of Right quantity is being reduced and in Anglian region, for example, it is less than 30% of the 1965 quantity (D. Evans, personal communication). The forecast public water supply demands for 2021 (Table II) include a total of 300 Ml/day to account for the loss of available yield resulting from varying or revoking abstraction licences to improve ALF rivers.

The early history of flow management. A treatise on the Laws and Statutes of Sewers (defined in old english as a 'freshwater trench or little river') published in 1732, consolidated the established business and practices of the long-established Commissioners of Sewers (Mears, 1732). This work makes clear that early river management envisaged rivers, sewers and streams as having two primary uses: 'the one for draining, the other for sailing' (p. 43). It is also made clear that the Commissioners of Sewers had no power by law to promote by order or decree any works to supply water for 'use of cattle, or other household occasions, as for brewing, washing, and such like'. Their powers did not extend to providing water 'in help and supply of navigation' where such navigation was for the 'common use of people in general' (p.43). Indeed, the general principle of setting statutory minimum flows is embedded in late 18th century acts for maintaining navigable canals. For example, the Grantham Canal Navigation Act (1793) includes the following control on abstractions:

> the natural Stream of the said Brook...to be guarded by a permanent Gauge Weir, that no Water shall flow or be taken from the said Brook into said Reservoir or Reservoirs, until the Water flowing down the Channel of the said Brook shall be double in Quantity to what shall be deemed the Average Produce of the Brook in common dry seasons...in the months of May, June and July.

The concept was widely utilized in a number of Private Acts towards the end of the 19th century (Sheail, 1984, 1987), making provision for flows, usually compensatory, with regard to rivers where the flow would be significantly influenced by the works, such as reservoir constructions, authorized by the Private Act. Although several of these acts included provisions to protect fisheries, the main factors determining a prescribed minimum flow were navigation requirements, the safeguard of public health and the rights of downstream abstractors.

The present situation. The Water Resources Act 1963 (s.19) required River Authorities to set minimum acceptable flows (MAFs) and to review them periodically. Under s.21 of the Water Resources Act 1991, the National Rivers Authority was given the power to submit (to the Department of the Environment) for approval a statement of MAFs. A 'minimum acceptable flow' is defined as whatever flow, level or volume is set by the authority having regard to the particular circumstances, subject to approval or amendment by the Secretary of State. There is no more precise legal definition.

However, the law does lay down what factors need to be considered in setting the flow. A MAF must be not less than the minimum which the authority considers necessary to safeguard the public health and to meet:

(a) the requirements of the existing lawful uses of the inland waters, whether for agriculture, industry, water supply or other purposes, and

(b) to meet the requirements in relation to both those waters and other inland waters whose flow may be affected by changes in the flow of those waters, of navigation, fisheries or land drainage.

It is made clear that the issue of quality, as opposed to simply quantity, of water must be taken into account. The law also requires that the control points where the flow is to be measured, the method of measurement at each point (it may be different at each) and, if applicable, the MAF for the different points, must be specified. The law provides for a very flexible approach in order that the authority can respond to the particular circumstances of the river in question. However, the law says nothing about what technique is to be used to determine the MAF and no guidelines have been produced to facilitate the setting of MAFs. Consequently, no formal minimum acceptable flows have been set.

Since the 1963 act, all new licences have contained conditions to protect the water environment where necessary. The minimum acceptable flow 'concept' has become embedded in the abstraction licensing process and has been widely used in the setting of controls on abstractions. The primary objectives have been to protect historic navigation rights, water quality (including the prevention of saline intrusion), abstractions from the lower river and fisheries. Flow conditions have been set to protect downstream interests giving due regard to the principle of 'first come, first served', i.e. the historic sequence that licences were granted, with more recent licences having a higher control than older ones (a process known as 'stacking'). Most of the controls are 'hands-off' conditions; some are 'maintained flows' requiring river support, by groundwater pumping or reservoir compensation, under extreme low flows. However, those licenses with flow conditions attached (numbering about 1500) represent a small proportion of the total number of licences. They also represent a relatively small proportion of the total volume of the water licensed for abstraction. Furthermore, the majority of licences with flow conditions attached relate to small-scale abstractions which are self-regulated by monitoring levels at a gauging station immediately downstream of the abstraction point. Currently, in England and Wales there are only 37 gauging stations that act as control points for ten or more abstraction licences.

A future ecological flow policy. Existing legislation allows for a statutory minimum acceptable flow regime to be set and the NRA's Corporate Plan 1994/5 (NRA, 1994b) advanced a policy for setting river flow objectives (RFOs): 'those flows which need to be protected to ensure the river can support the abstraction requirements placed on it without compromising important ecosystems' (p. 12). Mechanisms and procedures are yet to be agreed for determining and implementing RFOs, but a key issue defined by the corporate plan, is the development of quantitative criteria for setting environmental flow requirements. For the first time, explicit recognition is given to ecological needs within water resources management.

The main advantage of a statutory ecological flow policy would be the creation of an open procedure that would receive the confidence of the public, conservation groups and other interested organizations. New legislation may be required to introduce powers to challenge the historical legacy of water allocations, especially for navigation and abstraction, if ecological needs are to be given at least equal weight to those of other users. Furthermore, the operation of an ecological flow policy with 'hands-off' flows defined by an ecologically acceptable flow regime, would require the specification of a suite of control rules attaching seasonal and perhaps more specific conditions to abstraction licences. Traditionally, complex control rules for operating abstractions have been seen as unnecessary complications for water resources management, but such rules will be necessary to allow exploitation of those flows that are not required to meet ecological needs.

ECOLOGICALLY ACCEPTABLE FLOW REGIMES

Holistic streamflow management requires the derivation of an ecologically acceptable flow regime (EAFR) based upon sound scientific principles. Traditionally, the provision of flow controls has considered only minimum flows; the conservation or restoration of river ecosystems requires consideration of the full range of flows experienced.

An approach to defining EAFRs

A general procedure for establishing the EAFR is outlined in Figure 2. In some cases, such as rivers

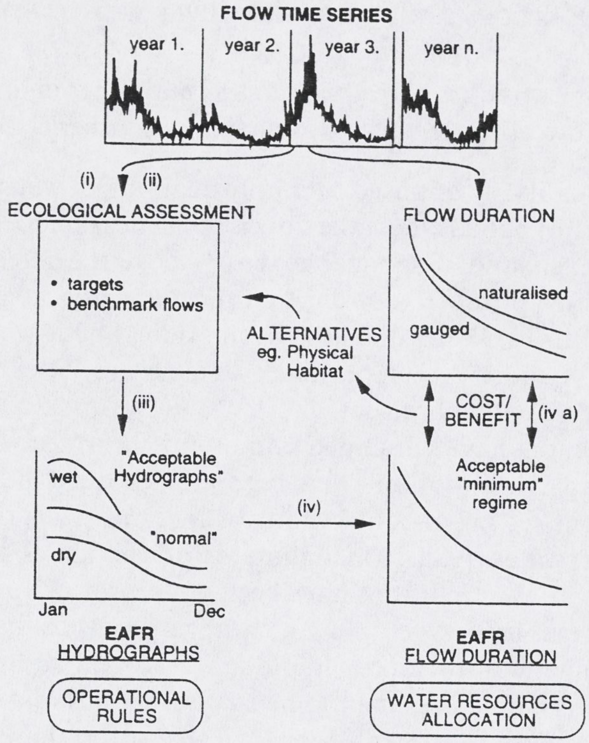

Figure 2. A general procedure for deriving an ecologically acceptable flow regime (EAFR) represented as one or more hydrogaphs for defining operational rules and as a flow duration curve for assessing abstractable volumes. The procedure allows the evaluation of alternatives including physical habitat improvements as part of the decision-making process

regulated for hydroelectrical power production, restoration of flows may require only a redistribution of flows during the year, but in other cases, where river flows are reduced by abstractions and diversions, the water volume to be reserved to meet ecological needs must be determined, as well as the timing of flows. Derivation of the EAFR involves four steps.

(i) Ecological assessments. The first step is to define a hierarchical set of ecological objectives and associated targets. Each river should be classified into (a) major sectors, on the basis of hydrology, water quality and river corridor structure; and (b) reach types, defined by channel form and riparian vegetation. The primary ecological objective (PEO) for a sector should be based on a full review of the available hydrological, geomorphological, ecological and management information, including historical records. It should be derived following an evaluation of all user needs, current and forecast over the planning period, and consideration of restoration or enhancement opportunities. The PEO should be time-limited with a review linked to each 25-year water resource planning cycle.

Once the PEO has been defined, specific ecological targets must be set. This involves three stages; (a) define appropriate target(s), which can be a life stage of a particular species (e.g. an indicator of keystone species), or some measure of river 'health' such as an index of macroinverterate diversity, channel structure or riparian vegetation quality; (b) identify the critical time of the year for the target (e.g. end of summer for juvenile trout, autumn for trout spawning, spring for flooding riparian wetlands); and (c) specify the 'acceptable' conditions (e.g. end of summer flows maintaining at least 10% of the optimum usable habitat area for juvenile trout in all reach types', 'flows in November ensuring optimum spawning habitat for trout in one reach type', 'river levels ensuring that the riparian wetlands in a specified reach type are inundated for at least 30 days in March and April'). Thus, an ecologically acceptable flow regime may be defined from a suite of targets that prescribe minimum acceptable flows at different times of the year.

The specification of ecological targets incorporates the concept of 'acceptable' loss. In most cases, the decision as to whether or not a loss of habitat, species, density, etc. is acceptable is, at best, based on past experience. Specific thresholds, such as '10% of the optimum usable habitat area for juvenile trout' must be based upon the best judgement until future research develops improved models of flow–biota relationships. Even when an absolute threshold is used, such as the flow at which all habitat for a particular species or life stage is lost, a subjective decision must still be made: is the loss 'acceptable' in some reaches or sectors but not in others? In practice, the determination of the acceptable ecological targets, is based as much on social, cultural and economic factors as on scientific ones. However, the evaluation of the EAFR is an iterative process (Figure 2) and the targets may be revised following comparison of the EAFR with actual (i.e. historical, gauged or naturalized) flow time-series or durations. In this way, ecological needs can be balanced against the needs of other users on the basis of the best available ecological information.

(ii) Benchmark flows. The second step is to determine the flows required to meet the ecological targets, these may be termed 'benchmark flows'. Methods for determining these flows may be classified as four groups: (a) hydrological indices, (b) habitat assessment, (c) analyses of historical data sets and (d) habitat simulation models (e.g. PHABSIM). These methods have been reviewed by Petts and Maddock (1994) and the latest developments are reported in a Special Issue of this journal (1996, vol. **11**, nos. 2 & 3).

(iii) Ecologically acceptable hydrographs. Having defined the benchmark flows to meet the ecological targets for each sector of river concerned, the third step is to give 'acceptable' frequencies and/or durations to the benchmark flows. The 'fluvial hydrosystem' is adapted to the normal range of flows from year to year and this dynamism is important for sustaining the integrity of the ecosystems. Given current scientific knowledge, this process of assigning acceptable frequencies and durations is largely arbitrary but decisions may be guided by combining detailed habitat assessment approaches with analyses of historical data series (of flows, invertebrate indices, fish year-class strengths, etc.). The specification of 'normal', wet year and dry year hydrographs is important for defining operational rules for managing river flows. Such rules may guide the setting of conditions attached to abstraction licences governing when, and how much, water may be taken.

(iv) Ecologically acceptable flow duration curve. The fourth step is to combine the 'ecologically acceptable hydrographs' into a flow duration curve for determining the allocation of water required to achieve the agreed targets. This can then be compared with the historical series of gauged and naturalized flows to assess the volume available for abstraction and to enable a cost–benefit analysis of the ecological needs in relation to other uses. For example, opportunities to introduce other management measures (e.g. physical habitat improvements) may be considered or alternative ecological targets, with lower flow requirements, may be evaluated at least until such time as alternative actions can be implemented to meet (or reduce) the needs for other users.

Scientific principles for defining ecological targets

The primary need is to define appropriate ecological targets. Six general scientific principles underpin the determination of ecological needs: longitudinal connectivity, vertical exchanges, floodplain flows, channel maintenance flows, minimum flows and optimum flows. Traditionally, the basis of flow allocations to meet environmental needs has considered only the annual minimum flow. The approach developed here includes both seasonal and annual flow variations (see also Petts and Maddock, 1994; Petts *et al.*, 1995).

(i) Longitudinal connectivity. Rivers are characterized by longitudinal gradients of physicochemical processes, channel forms and biological communities. Such downstream variations represent a zonation of channel types, each characterized by specific combinations of processes, sets of landforms and habitats and communities of flora and fauna. As an operational minimum, each river must be subdivided into four sectors and ecological targets specified for each: headwater stream, middle river, lowland river, estuary. Rivers should also be viewed as longitudinal *continua* dominated by downstream transfers of energy and matter (Vannote *et al.*, 1980). The need to sustain longitudinal connectivity, linking cool, shallow, steep-gradient headwater streams and the warm, deep, shallow-gradient lowland river, is an important principle for river management. Longitudinal connectivity may be especially important at certain times of the year (e.g. to enable the annual spawning run of salmonids).

(ii) Vertical exchanges. Many rivers flow above important alluvial aquifers, formed of permeable sediments. On the Flathead River, Montana, USA, for example, the 'interface' between surface water and groundwater environments extends 10 m vertically and about 1500 m laterally (Stanford and Ward, 1988).

Within the floodplain, 'springs' give rise to distinctive habitats. Groundwater upwelling also produces clear ecological patterns within river channels (e.g. Maddock *et al.*, 1995) that influence distributions of benthic fauna at the scale of a river reach (Creuze des Chatelliers and Reygrobellet, 1990) and individual riffle (Sterba *et al.*, 1992). Over abstraction of water from alluvial aquifers can markedly influence these important surface-water and groundwater exchanges. Thus, Shepherd *et al.* (1986) suggested that the influence of flow on processes and biological communities at the surface-water and groundwater interface should be of concern to all those involved in fisheries research, benthic inverterate studies and environmental impact assessments.

(iii) Floodplain flows. Both aquatic and floodplain biota are adapted to the range of high flows, to the timing of these flows in relation to the temperature regime and to the predictability of the seasonal flow variations. The roles of these hydrological characteristics have been consolidated into the flood–pulse concept (Junk *et al.*, 1987) which has particular importance for the productivity of river fisheries (Bayley, 1991). It is now widely recognized that the maintenance and restoration of the lateral connectivity across the river corridor is vital for sustaining the ecological integrity of large rivers (Junk *et al.*, 1987; Petts 1996; Welcome, 1977; also *Regulated Rivers* Special Issue 1995, Vol. 11).

(iv) Channel maintenance flows. Wet years are particularly important for sustaining the gross morphology of the channel and floodplain systems (see, e.g. Gurnell and Petts, 1995). Channel form is affected by the full range of flows, but the macroscale structure of river channels is adjusted to the discharge at bank full stage, which on many rivers equates to the 1·5-year flood. Rarer floods (say greater than the 1 : 20-year event) are also important in sustaining river ecosystems, especially in structuring floodplain communities by causing major erosion (including channel cut-off) and deposition (e.g. Amoros *et al.*, 1987; Salo, 1990). Although extensive flooding and highly unstable channels may be incompatible with other human uses of river corridors, floodplain inundation and channel mobility within some sectors, or within the confines of an acceptable corridor, can have significant ecosystem benefits.

(v) Determine the minimum acceptable flow. The need to allocate water to sustain the aquatic and semi-aquatic ecosystems within the river corridor is well established. Water is needed to sustain biota directly and indirectly; for example, by preventing water quality deterioration (i.e. adequate dilution of effluents and flow velocities to prevent stagnation) and siltation of the channel bed. 'Normal' and 'drought-year' minimum flows may be defined; the former being a 'hands-off' flow and the latter a 'maintained flow'.

(vi) Determine optimum flows. Natural biological populations vary widely from year to year. Strong year-classes in one year balance low populations in another. Natural community dynamics reflect this complex interaction between the different populations, as well as the effects of other biological and physical processes. Whilst such conditions in nature occur infrequently, their natural frequency and duration should be considered, and whenever possible preserved, in determining the ecologically acceptable regimes.

An EAFR for the River Babingley, Anglia Region, UK

The upper Babingley is a classic example of an unpolluted, groundwater-dominated, chalk stream (Petts, 1994a). It is fed by a major springhead which provides up to 90% of the river flow (naturalized mean flow is 0·64 cumecs). The effective catchment area of the groundwater system (80 km^2), is about twice the topographic catchment. The trout stream has a reasonably rich macroinvertebrate fauna and macrophyte flora (dominated by *Hippurus*, *Rorippa* and *Ranunculus*). The major problem for adult trout under extreme low flows is the lack of deep pools, which become infilled with sand. Field surveys were undertaken during 1991–1992—a period of severe drought when maximum flow was only 0·273 cumecs (only slightly above the simulated natural 95th percentile flow for the period of record, 1977–1992).

As shown in Table II, Anglian Region is projected to have a public water deficit in 2021 and options to meet the projected demand include increased abstractions from the chalk aquifer. A study was undertaken to establish the EAFR for the Babingley to aid water resources management (Petts, 1994a) using the approach described in Figure 2. The ecological target was to protect the trout population. Six benchmark flows were defined (Table III).

(1) The channel maintenance flow (CMF) is the gauged bankfull flow which has a return period of five years (this frequency was determined from field observation).

Table III. Benchmark flows (see text for key) determined for the River Babingley and their 'acceptable' flow duration percentiles: EAFR1 is to protect the 'natural' river and EAFR2 is to protect the river if weirs are used to maintain pools during drought conditions, providing refuge habitats for trout. The River Wissey is another chalk stream in the same region (Petts, 1994b)

Benchmark	General target	Method	Flow (cumecs)	Flow duration (%)	
				EAFR1	EAFR2
CMF	Bankfull discharge	Field survey and flow data	1·80	0·3	0·3
HMF	Flushing flow	0·66 × CMF	1·20	1·5	1·5
OEF	Optimum usable habitat for adult trout	Transfer from River Wissey PHABISM study	0·70	10	10
DEF	Overwinter habitat for adult trout in all reach types along the river	Transfer from River Wissey PHABSIM study	0·45	27	27
AEF1	Minimum flow to protect adult trout in summer and autumn spawning habitat	PHABSIM	0·28	87	55
AEF2	Minimum summer flow to protect juvenile trout	PHABSIM	0·20		87
TEF1	Minimum summer flow to protect juvenile trout	PHABSIM	0·20	100	
TEF2	Minimum summer flow to protect the invertebrate community	PHABSIM, and historical analysis	0·10		100

(2) The habitat maintenance flow (HMF) is a normal 'flushing flow', important for preventing problems of excessive siltation and accumulation of organic detritus.
(3) The optimum ecological flow (OEF), provides optimum physical habitat for the target.
(4) The desirable ecological flow (DEF) will sustain usable overwintering habitat, and will sustain connectivity throughout the river system over the normal winter period, determined from historical flow records.
(5) The adequate ecological flow (AEF) is the normal end of summer flow.
(6) The TEF is the threshold flow below which all habitat for the target disappears (here given an arbitrary frequency of five years).

The benchmark flows were used to construct three hydrogaphs considered acceptable in wet, average and dry years (Figure 3A). These were combined to form acceptable flow duration curves for comparison with the gauged and naturalized flow data (Figure 3B). In addition, an EAFR was determined (EAFR2) for a scenario where pools would be sustained artificially, by introducing weirs to create scour holes. During the severe 1989–1992 drought, adult trout were observed to find refuge in such holes. The EAFRs were then used to determine the volume of water required to sustain the river as a trout stream—about 62% of the gross resource (12 000 tcm) with 8 000 tcm available for abstraction. The study also showed that the use of weirs during droughts to sustain physical habitats would allow the AEF and TEF to be reduced, thereby increasing the abstractable volume to 9 000 tcm.

DISCUSSION AND CONCLUSION

The sustainability of river ecosystems is related to (a) flow, (b) water quality, (c) physical habitat and (d) the 'naturalness' of the biological communities (including both introduced and invasive species). In England and Wales, in common with most of Europe and numerous rivers world-wide, the achievement

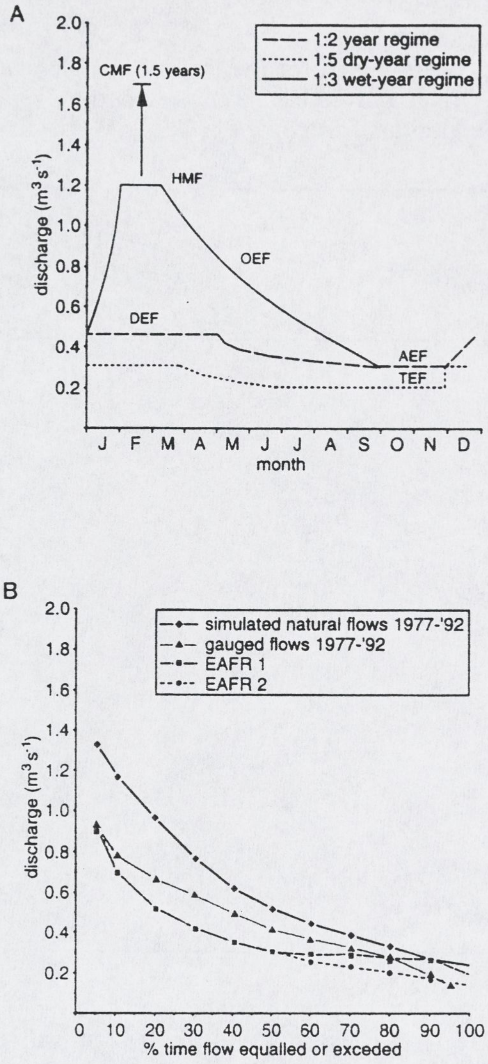

Figure 3. EAFRs for the River Babingley based upon data summarized in Table III (after Petts, 1994a). (A) 'Acceptable' hydrographs and (B) EAFR flow duration curves compared with simulated natural and gauged flows

of environmentally sound river regulation policies is seen as constrained by historical prerogatives and the legacy of past water allocations (in the UK often contained, for example, within navigation Acts), channel engineering works, pollution and exotic species introductions. Strong arguments may be presented to protect the remaining naturally functioning ecosystems (e.g. Boon, 1992). In many cases, the historical legacy of environmental change has created 'artificial' systems (Figure 4); some of these may be so ecologically degraded as to be considered 'derelict' (Book, 1992) but in other cases they may be highly valued by society. A good example of the latter, is the trout fisheries (introduced species often sustained by hatcheries), sustained by cool-water releases from dams, that have replaced warm-water fisheries in some semi-arid areas (see Petts, 1984). Other rivers may be viewed as 'alternative' systems retaining some characteristics of the naturally functioning rivers typical of the geographical setting but also some artificially influenced components.

A key question for science is to establish the appropriate mechanisms, and the level of support required, to conserve river ecosystems (natural, alternative and artificial) that are highly valued by society and to restore or enhance those that are not. The scientific context for environmentally sound river management is clearly established (e.g. Callow and Petts, 1992, 1994) and considerable progress has been made in developing models of river ecosystems for evaluating management options. This knowledge provides important information to *guide* the decision-making process. Progress in developing relationships between hydrological change and

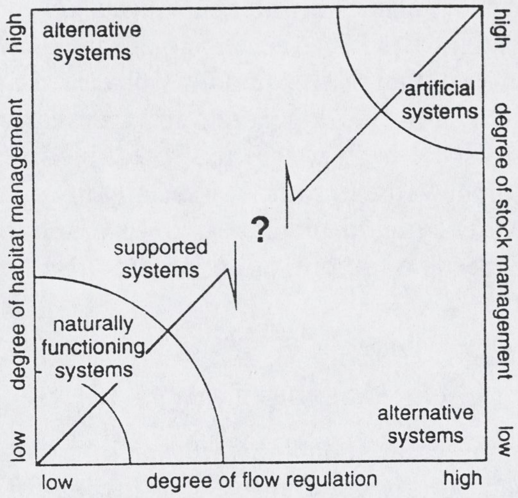

Figure 4. A classification of rivers according to the degree of artificial influences. Alternative systems retain some natural characteristics. An example of an artificial system is a channelized river with an intensively regulated flow regime and a fish population sustained by stocking. In many cases the aim of restoration is to establish supported systems in the same biogeographical region. However, the magnitude of support is uncertain especially when long time-scales are considered

habitat for biological indicators (e.g. PHABSIM) has initiated a change in river management which is now able to evaluate ecological effects.

The models are imprecise, and ecosystem response to flow regulation, physical habitat alteration and manipulation of biological communities is, as yet, indeterminate and the models remain qualitative. Furthermore, despite the quantitative nature of some habitat models, the decisions on the 'acceptability' of a particular flow scenario depend upon a number of value judgements.

The ecologically sound allocation of river flow is a fundamental component of environmentally sound river management. The approach discussed herein is based upon a number of established scientific principles. It moves away from the concept of a single 'acceptable minimum flow' or a 'single acceptable minimum flow hydrograph' to advance an ecologically acceptable flow regime (EAFR) that recognizes the functional role of between-year, as well as between-season, flow variations. However, at a number of important stages in the method choices must be based upon experience: e.g. the choice of ecological targets (indicators of ecosystem health), the definition of 'acceptable' change in each target and the choice of 'acceptable frequencies' to be attached to the different (wet year, normal and drought year) hydrographs. Research on historical data series linking flows and measures of ecosystem health needs to be integrated with functional studies of ecological processes if progress is to be made in advancing end user-driven models of river ecosystem integrity.

From a management perspective, a priority must be to develop an approach for specifying long-term ecological objectives to underpin the definition of river flow objectives, for each sector of river. In many cases, because of the historical legacy of ecological change, restoration of natural systems will not be practicable; enhancement measures to achieve alternative ecological states that are more highly valued by society will provide the basis for progressing towards the ecological objectives. In most cases of rivers that are over-abstracted or have unacceptable flow regimes, enhancement measures will not involve new flow controls alone, but will also involve physical habitat management and perhaps controls on biological populations as well.

The flow assessment method illustrated in this paper offers an approach for evaluating different management options and for assessing the feasibility of different ecological objectives. As a component of integrated land and water management, the setting of river flow objectives will make a positive contribution to advancing catchment management planning; invoking a precautionary approach will ensure that the best practicable option is chosen with ecosystem sustainability given a much higher priority than in the past. In England and Wales, the new Environmental Agency will be well positioned to introduce EAFRs which will have significant bearing on decisions to promote strategic options to meet future water demands.

The importance of protecting biodiversity and self-sustaining ecosystems was recognized by the international community at the Rio Summit, but it has major implications for the ways in which we manage and use our water resources. Throughout history, drought and water shortages have forced human innovation and technological advancement. Failure to adapt has led to economic decline, depopulation, land degradation and political instability. There is no doubt that if the summit's charge that natural resources must be used in ways that ensure their availability for future generations, then early stabilization of population size is vital to any strategy (PEP, 1993). However, if we are to protect biodiversity then we shall also need to recognize water as a limited (albeit a renewable) resource, especially in irrigation agriculture; to develop innovative new technologies to reduce water demand and increase re-use; and to promote scientifically based approaches to determining ecological needs and controlling abstractions from both groundwater and surface-water resources.

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Procedural Justice in Fishery Resource Allocations

By Cheryl Perusse Daigle, David K. Loomis, and Robert B. Ditton

ABSTRACT

Demands on scarce fishery resources have resulted in the need for allocation decisions. These decisions often entail choosing among various groups; some receive the resources they desire, others do not. Dissatisfaction with such allocation decisions and procedures is problematic for allocators, recipients, and nonrecipients. Thus, allocators should develop decision-making processes that minimize or prevent conflict yet continue to allocate resources wisely. Research on *distributive justice*, defined as "the fairness of the actual distribution of resources," provides insight into how those affected by proposed allocations are likely to react. A second approach is *procedural justice*, or "the fairness of the decision-making process that leads to a distribution of resources." An understanding of procedural justice can help resource managers determine whether perceptions of fairness or satisfaction arise from the final allocation decision, the manner in which a decision was made, or a combination of the two. This paper introduces the concept of procedural justice as it relates to fishery resource decision-making and management, describes its potential for understanding what causes or increases dissatisfaction with allocation decisions, and suggests procedures to minimize or prevent conflict. A case study involving sport-fishery management in East Matagorda Bay, Texas, is analyzed from a procedural justice perspective.

Because of demands on increasingly scarce fishery resources, allocation decisions are required. Often these decisions entail choosing among various groups; some will obtain the resources they desire, some will not. Conflicts caused by dissatisfaction regarding allocation decisions and procedures cause problems for allocators, recipients, and nonrecipients, and time and money spent on conflict resolution efforts can be costly. Thus, allocators should develop decision-making processes that minimize or prevent conflict yet continue to allocate resources wisely.

Recent resource allocation research has taken a human dimensions perspective to better understand why conflicts occur. In particular, research has focused on the fairness of allocation decision making. Research on *distributive justice*, defined as 'the fairness of the actual distribution of resources' (Loomis and Ditton 1993), shows potential in predicting the likely reaction of those affected by proposed allocations. Also, research on distributive justice is useful for understanding the behavior of recipients and nonrecipients after an allocation decision has been made (Ritter 1991; Loomis and Ditton 1993).

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Another approach for understanding fairness issues is *procedural justice*, or "the fairness of the decision-making process that leads to a distribution of resources" (Folger et al. 1983). Concepts of procedural justice can help determine whether perceptions of fairness or satisfaction arise from the final decision, the manner in which a decision was made, or a combination of the two.

Little attention has been given to procedures used to allocate natural resources and the reaction of affected groups to the actual distribution of resources as well as to the procedures that led to the distribution. Previous research in organizational and court settings has application value toward solving problems in the area of natural resource allocations.

The purpose of this paper is to introduce the concept of procedural justice as it relates to fishery resource decision making and management, suggest its potential for understanding what causes or increases dissatisfaction with allocation decisions, and suggest procedures that can minimize or prevent conflict. Finally, we analyze from a procedural justice perspective a case study involving sport-fishery management in East Matagorda Bay, Texas, reported earlier (Matlock et al. 1988; Ritter 1991; Loomis and Ditton 1993).

Procedural Justice

In contrast with distributive justice, which deals with the fairness of a distribution of resources, procedural justice deals with the fairness of the mechanisms, structures, and processes that lead to the distribution (Folger et al. 1983). Although distributive and procedural justice contact people for human dimensions work, those who completed our survey, were not asked for their background training, but a diversity of backgrounds is represented. We know that some respondents have formal training and degrees in the social sciences, whereas others have a traditional fisheries background but are interested in human dimensions or have taken continuing education courses to develop their expertise. In the future, we expect to see increased numbers of personnel formally trained in various aspects of human dimensions with a capability of supporting an integrated approach to fisheries management. This may be the best indicator of the adoption and diffusion of human dimensions information within fisheries management.

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are related and influence each other, individuals perceive them to be distinct when reacting to allocation decisions (Thibaut and Walker 1975; Leventhal et al. 1980). Distributive and procedural justice are independent to the extent that an unfair procedure may produce a fair outcome, or a fair procedure may result in an unfair outcome (Folger 1977). However, certain aspects of the procedures used may influence perception of the distribution and vice versa. Whereas early work in this field suggested a positive relationship between distributive and procedural justice, subsequent efforts have demonstrated that procedural justice is important in its own right (Tyler 1988). Today, the broad concept of procedural justice is composed of several developing models. Two independent approaches to procedural justice provide a foundation for current knowledge: Leventhal's (1980) expansion of his justice judgment model and Thibaut's and Walker's (1975) control theory of procedural justice.

Some Basics of Procedural Justice

To judge the fairness of an allocation process, Leventhal (1980) suggested that individuals form a cognitive map of the procedural components of the process that shapes their evaluation of procedural fairness. Leventhal proposed seven categories of procedural components; these may be evaluated individually or in combination by those affected by an allocation. They include (1) the selection of decision makers; (2) the setting of ground rules concerning the availability of information about an allocation and how to obtain it; (3) the way information is gathered to evaluate the potential recipients; (4) the decision-making structure; (5) the appeals process; (6) the safeguards that exist to monitor the integrity of decision makers; and (7) the change mechanisms available if existing procedures fail (Leventhal 1980).

An individual may then use one or more of six procedural justice rules to evaluate each component. A *justice rule* is "an individual's belief that a distribution of outcomes, or procedure for distributing outcomes, is fair and appropriate when it satisfies certain criteria" (Leventhal 1980:30).

(1) *Consistency rule*—The process is perceived to be consistent across persons and through time ("equality of opportunity").
(2) *Bias-suppression rule*—The allocator's personal self-interest or blind allegiance to narrow preconceptions is suppressed at all times.
(3) *Accuracy rule*—The information used in the decision-making process is believed to be accurate.
(4) *Correctability rule*—The potential exists for modification or reversal of decisions throughout the process.
(5) *Representativeness rule*—The opportunity to voice opinions or concerns is open to all individuals or groups affected by the decision.
(6) *Ethicality rule*—The procedures used are consistent with the individual's or group's moral and ethical values.

Thibaut and Walker (1975) approached the concept of procedural justice from a narrower perspective. They developed a model to explain procedural preferences and understand how people determine procedural fairness within the context of dispute resolution. Two types of control over resolution of a dispute were distinguished: decision control and process control. *Decision control* is the individual's control over actual decisions made (v third-party control), while *process control* refers to an individual's control over the presentation of "facts" (or the opportunity to state one's case) to a third party. Thibaut and Walker (1975) suggest that the key characteristic in forming an individual's perception of procedural justice is the distribution of control between the individual and the decision maker (Lind and Tyler 1988).

Providing individuals with an opportunity to voice their opinions and concerns regarding allocations leads them to believe they have been treated fairly...and increases satisfaction with decision makers.

Individuals are thought to prefer to maximize their control over decisions by directly participating in the decision-making process (decision control) (Thibaut and Walker 1975). If unable to do so, they seek to *indirectly* influence the decision by maximizing control over the process that leads to a decision. This concept of procedural justice was termed the *instrumental perspective* when subsequent research led to speculation that control was not always an important factor when individuals were considering the fairness of procedures used in an allocation (Tyler et al. 1985; Tyler 1988). Alternately, the noninstrumental or *value-expressive effect* claims that "people value having the chance to state their case, irrespective of whether their statement influences the decisions of the authorities" (Tyler 1987). This is in contrast to Thibaut's and Walker's perspective in which the emphasis is on having some type of control over the decision (Lind and Tyler 1988; Tyler 1988).

The value-expressive effect is more thoroughly explored as the concept of *voice*, or "having some form of participation in decision making by expressing one's own opinion" (Folger 1977:109). Providing individuals with an opportunity to voice their opinions and concerns regarding allocations leads them to believe they have been treated more fairly whether or not their input influences the decision (Tyler 1987; Lind et al. 1990). This perception also increases satisfaction with decision makers, suggesting that public support for decisions may be increased by paying more attention to efforts that allow public input. Fairness is perceived to be greater when the opportunity to voice one's concerns is combined with the possibility of influencing the decision (Lind et al. 1990).