

How to Get Snookered Without Even Trying

Preface

There are a number of ways to get 'snookered'. Some of them can occur during the technical phase of a Federal Energy Regulatory Commission (FERC) relicensing process. We all generally realize that the very nature of the FERC (an energy regulator) 'relicensing' sets the resource agencies up for an acceptance of current conditions (the dam and power generation), and that resource concessions will be made. In no way should it be construed by the following expose' that consultants or power companies are dishonest – in fact, you should assume that they are doing as you are and would – looking out for their organization's best interest. But shenanigans will occur – you should expect them. Recognizing what is going on is the first step; what we hope to avoid is any resource agency naiveties in the study design, data collection, and analysis phases of the FERC process which effectively tilt the playing field any further. Politics and economics (very often just different words for the same thing) are a reality. Ideally, we want to keep politics and science discreet, at least as much as possible.

The Instream Flow Group out of Fort Collins provided information and caveats for many of these same issues, though more likely in a more neutral, 'scientific' tone. There is also a S.P.E.C. (Study Plan Evaluation and Checklist) Report available that covers most of the conceivable issues you are likely to see.

What follows is a presentation of some MN experiences with PHABSIM studies conducted by power company staff and consultants. I have created headers or categories for the strategies being used: I'm sure there are variations on these general themes and perhaps other ways to group them. The Minnesota experience is obviously not unique, and is offered as an example of what to look for and one way to respond. Through dumb luck and a healthy dose of contrariness, we were able to negotiate the relicensing process and accomplish positive change for the resource. However, the political context the FERC operates in cannot be ignored; today there is no guarantee of your results. At the very least you will be aware of what is being done to the generations and resource(s) you represent.

Background for the St. Louis River Project

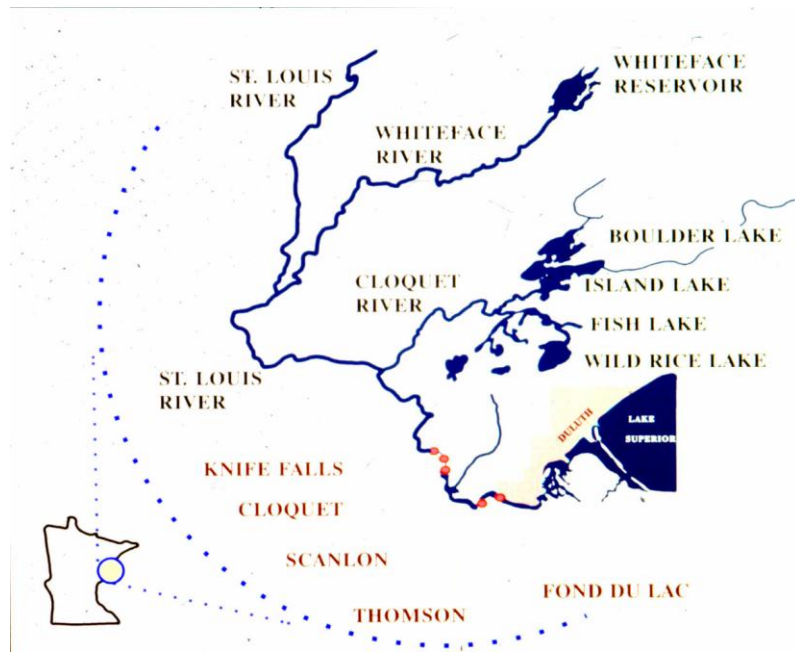
1) The project is operated under a FERC license, re-issued in 1995.

2) The St. Louis River relicensing constituted a large (150 miles of river with 5 hydropower projects affected), hydrologically complex project (see attached figure).

Covering approximately 8280 acres at full pool, Island Lake Reservoir was created during the years 1914-1920, for power production. In a sense, the reservoir exists today largely because of its utility for power generation.

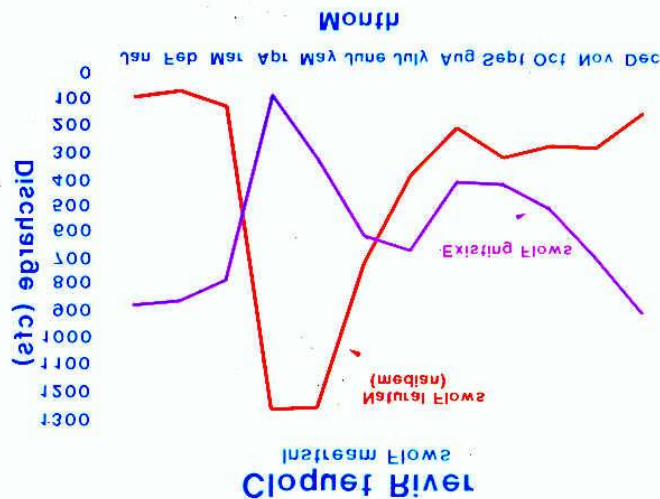
3) The St. Louis Project represents the largest hydropower project in Minnesota –power is an existing and economically important use. At the same time, the environmental impact of dams and hydropower on river systems is widely known and recognized as real and significant. As a result, the FERC, in balancing between power production and the restoration and enhancement of fish, wildlife and recreation, forced concessions to these other uses and values of the river. The Final EIS document specified that the concessions MP made on their FERC relicensing, which included the change in

maximum drawdown rate on Island Reservoir and establishment of seasonal flow releases, cost 1.8 million dollars annually (change in levelized net annual power benefits).



4) The FERC process took more than five years and involved stream habitat, hydrologic and reservoir modeling

5) Past operations focused on power generation only (see figure below)



Introduction

During the relicensing of the St. Louis River project, the Minnesota Dept. of Natural Resources staff were exposed to a series of technical and philosophical issues, centered around the use of the IFIM. At the time our familiarity with this collection of models and procedures was, at best, 'dangerous'. We were at the stage where we were very familiar with certain aspects (data collection, PHABSIM modeling, summary, etc.), but were almost completely unaware of how the fundamental assumptions, study design and specialized interpretation of the study results could be used unscrupulously. Eight of the main issues we encountered are presented below:

Derivation of Instream Flow Recommendations

- 1) Your 'management goal';
- 2) Species selection and phenology;
- 3) Transect weighting;
- 4) Transect Placement;
- 5) Hydrology and Simulated Flow Range;
- 6) Derivation of Fisheries 'Minimum' Flows;
- 7) Reservoir Operations Modeling;
- 8) Habitat Time Series Analysis.

Under each of these items are presented: 1) an issue definition, 2) what's at stake, 3) a general response (*advice*), and, 4) a specific response (one used in the FERC process for the St. Louis River relicensing).

1) *Your 'Management Goal'*.

Issue Definition. Stating your management goal clearly and concisely is, of course, an important first step in any instream flow study (see book 2). Everyone needs to know what the target is, before we start modeling. The PHABSIM will produce endless reams of output, therefore results can only be judged relative to stated goals and objectives.

What's at stake. What you should be aware of is the other edge to this sword in a FERC process. You will be held to whatever you come up with – for good or ill. Perhaps, the stream in question is known to be degraded and has not been actively managed for years. Coming up with a management plan at your first meeting with the consultants and power company, one that satisfies the entire Fisheries Division and will stand the test through a 5 or ten year FERC process may be a daunting task. Or maybe, if you had time and thought to ask the local Fisheries Manager, she gave you a response from her perspective that is really more of a products objective, for example: "We manage the reservoir for trophy smallmouth bass."

General response Be very careful with this question and do not answer it in terms of management *objective(s)*. While increasing the number of (or habitat for) trophy size smallmouth bass is a very understandable, specific, and straightforward objective, it is also exactly the type of answer for a management goal that a 'gaming' consultant needs to direct the science to his clients desired ends. If you are not explicit about the need for juvenile, fry and spawning habitat, as well as habitat for prey items (for each smallmouth bass life stage), the flows that form this habitat that such trophy fish and organisms that they need in their food cycle, you may end up trying to explain why more water is needed than that predicted just by the adult bass habitat output. My advice: adopt a goal that speaks to a broader, ecosystem perspective. Say and write it down early,

consistently, and often. Adopting an ecosystem perspective and goal clearly opens the door to the IFC's five component approach.

Specific response For the St. Louis River Relicensing the overall management goal for the involved rivers was: "To protect and enhance the fisheries on a community level." "The Leonard and Orth approach to PHABSIM habitat analysis was selected because it represents, to our knowledge, the best means to develop flow recommendations for warmwater/coolwater species assemblages. The point of conducting an IFIM study is to identify flows needed for fish and other instream uses; implicit is that these flows will be the "minimum" necessary for a given management objective so that offstream uses can also be developed. Research has shown that microhabitat availability for riffle-dependent species is most limited at low flows while micro-habitat availability for pool-dependent species is most limited at high flows (Orth and Leonard 1990). Key elements of the approach include the following:

- Selection of appropriate fish species and life stages on which to base analyses of instream flow needs is a critical step in determining flow regimes necessary to support fish populations (Orth 1987).
- Species selection is extremely important because flow dependent habitat characteristics of a stream (e.g., depth, velocity, substrate, cover) influence community structure and stability (Gorman and Karr 1978, Schlosser 1982, Moyle and Vondracek 1985). Changes in habitat characteristics may cause shifts in species composition (Bain, et al. 1988).
- Selected species should have, among them, a wide range of habitat needs (Leonard and Orth 1988).
- Because warmwater streams are characterized by high species richness (Orth 1987), direct analysis of habitat requirements for all species is not possible. The guild approach was used to simplify the species selection process.
- A guild is defined as "a group of species that exploit the same class of environmental resources in a similar way" (Root 1967).
- Food and habitat are the most important resource axes identified in previous resource-partitioning studies of stream fishes (Ross 1986).
- Species using similar resources should be affected similarly by the alteration of those resources (Roberts and O'Neil 1985).
- Consequently, recommendations for instream flow must represent a compromise among the needs of all species (Leonard and Orth 1988)."

2. *Species Selection and Phenology*

Issue Definition

Selecting the species and life stages for modeling is a fundamental aspect of PHABSIM analysis and extremely important. While it follows that the more complex stream fish assemblages demand explicit and careful consideration and selection of species to ensure all habitat types are modeled, it is erroneous to think that 'simpler' stream ecosystems (simpler in terms of # of fish species) can be approached lackadaisically.

Particular attention must also be paid to the timing of modeled life stages, to ensure maximum coincidence with temperature cues and flow regime requirements.

What's At Stake?

Certain life stages typically require more water (e.g., spawning), and others less (e.g., fry). Whenever there are storage reservoirs as part of the project operations, you can expect potential 'gaming' especially coinciding to key hydrology/operation months. For example, in Minnesota, peak flows typically occur in spring (April/May), precisely when the power company's operators seek to minimize outflows to refill the storage reservoirs. Conversely, November is naturally a lower flow month in Minnesota, but begins the drawdown cycle and so results in higher flows in downstream rivers. Inattention to these operation and hydrologic details can result in 'shifts' (large and small) in timing of desired flows for targeted species and life stages.

General Response

Know the basic biology of your organisms and insist on seasonal time frames that match what is occurring in nature. This area is the natural purview of the resource agencies and should not be abrogated under any circumstances. Cueing operation changes on hydrologic and temperature changes is best when possible, avoiding a rigid date-driven change which may be appropriate some years and wholly off during others. Be aware of the power company's desired operation schedule and protocols and how it matches with specific proposals relative to species life stages being modeled and the seasons they recognize.

Specific Response

"As we have discussed on several occasions with BEAK and MP representatives, we agree that walleye fry do occur in the St. Louis River as early as mid-May. We do not agree that it is appropriate to consider their habitat requirements during May. Walleye fry are planktonic during early development, they have no paired fins, are incapable of swimming horizontally, and are consequently not able to seek preferred habitat (Becker 1983). Several studies suggest that fry drift downstream into lakes during the early fry stage (Priegel 1970; Robert Strand, MDNR Regional Fisheries Supervisor, personal communications). Priegel (1970) found that if flows were insufficient to carry the fry into these downstream lakes within 3-5 days they would not survive. Walleye fry continue to live a pelagic existence until they are at least 25 mm long (Eschmeyer 1950; Morsell 1970). Walleye fry would not reach this size in May.

Reference is made by BEAK to the MDNR classification of walleye young-of-the-year (y-o-y) as walleyes up to 150 mm in length. Although we consider walleyes of this size to be y-o-y, we do not consider 150 mm walleyes to be fry. MDNR has not developed suitability criteria for walleye y-o-y; if we had done so, we would have partitioned the first year into fry and fingerling stages as we did with smallmouth bass. The suitability criteria used by BEAK were in fact for walleye fry (post-sac fry <50 mm) (Larry W. Kallemeyn, personal communications), not for y-o-y up to 150 mm as stated by BEAK. Therefore, we hold firm to our original position of considering walleye fry in June and July only.

We do not agree with MP that it is appropriate to include smallmouth bass spawning in May. During the spring of 1988 and 1989, two of the warmest years on record, we made observations of over 150 bass nests in the Zumbro River, which is 200 miles south of the St. Louis River. The earliest nest construction observed was May 19. A male bass may

construct several nests before settling on one for spawning (Mraz 1964) and each nest may take as long as two days to coincide with the onset of spawning. Because it is 200 miles further north and fed by shaded cool and coldwater streams, the St. Louis River should warm much more slowly than the Zumbro. Furthermore, average May flows under natural conditions are invariably higher than June flows in Minnesota streams. Smallmouth bass have adapted to these declining flows during the onset of spawning. These higher early flows may cause smallmouth bass to find slackwater areas that are less susceptible to fluctuating flows. Fluctuating and increasing flows during nesting have been shown to be detrimental to smallmouth bass spawning success (Simonson and Swenson 1990).

When defining the seasonal classes we attempted to identify time frames and associated species life-stage assemblages in a normal year. We do not imply that certain species-life stages will not appear outside of these time-frames in abnormal years. Rather, we feel that the seasons we have identified are the most important for the suggested species-life stages.”

3. Transect Weighting

Issue Definition

An important aspect of any modeling effort is to represent as much of the universe as possible. For PHABSIM studies, habitat mapping has been proposed as a way to represent or expand the sampled habitat to as much of the river as possible. Transect weighted is the means of transferring the transect data to the mapped river reach(es). The data from each transect are expanded to match the proportion of that habitat type in the mapped reach(es).

What's At Stake?

Although this seems straightforward and even desirable, there are problems with this approach. The underlying assumption of this approach is that the amount of habitat (area) is the key. One could argue that this is the basic assumption of PHABSIM itself (that habitat area is the key to population size), however, habitat is further 'qualified' by its degree of suitability in the PHABSIM model.

The effect of weighting transect data based on habitat mapping is to emphasize abundant habitat and discount rare habitat. In many streams, pool habitat is most abundant, and riffles are rare. Riffles are also typically more sensitive to flow changes (below bankfull) than pools; if we minimize their importance we minimize this impact.

General Response

Make it clear from the beginning and throughout the coordination process that rare or important habitat will not be weighted by area. Riffles are “biological hotspots” in river systems. As noted above, they are also the hydraulic control points in river segments, and are most sensitive to flow changes; if you protect riffles you tend to protect the rest of habitat. Of course there are exceptions to this (e.g., backwater habitat at stages above bankfull).

Specific Response

“MDNR has considerable concern regarding the weighting of transects and the application of species modeled in each transect. Specifically, MDNR is concerned with the dissection and weighting of the mainstem St. Louis and the upper and lower Cloquet study sites.

Weighting transects can be an extremely important determinant of IFIM results on two levels, if not done properly: 1) it may directly negate important but limited habitat, and 2) it can distort the habitat versus flow relationships for some species-life stages.

The National Ecology Research Center (NERC) recommends at least 5 to 7 transects be used to evaluate habitat availability. The MP/BEAK flow analysis and recommendations are based on only two transects on the Upper Cloquet and Mainstem St. Louis study locations. The transects used in this analysis are classified as shallow pool/slow run. It is well documented that pools are the least susceptible type of habitat to low flow conditions. By using only pool transects, available habitat in riffles, runs and transition zones is misrepresented in the analysis and the resulting flow recommendations are invalid.

In the Upper Cloquet site, BEAK placed a 50% weighting factor on transects 8 and 9, and negated the faster water areas (transects 1-7), the Upper Cloquet Island site. Transects 8 and 9 have water depths ranging between 3 and 5 feet and velocities generally less than 0.8 feet per second; they are pools. Subsequent application of riffle species in the pool transects (8 & 9) results in habitat for riffle species generally peaking at near zero discharges (for example, see Instream Flow Study Report, Figure D-11) and in a determination of "optimum" conditions to be at near-zero discharge. Similar results would be expected if BEAK re-ran all transects and used the 5% total weighting factor for transects 1 through 7. These transects are primarily composed of riffle and fast run habitat and must be considered a critical habitat type in this section of river. Since riffles are a major source of biomass production, and are in short supply in this section of the river, a weighting of five percent is not an accurate representation of their value to the ecosystem. This points out the necessity of applying appropriate species to appropriate habitat types (i.e., riffle species to riffles and pool species to pools) if the transects are separated, either directly or through weighting factors.

The lower Cloquet site is a high gradient river section. BEAK's inclusion of pool-dwelling, velocity-avoiding species into this study location is inappropriate. The resulting habitat analysis indicated that flows levels are not acceptable to these species until velocity is very low (i.e., little or no flow). The inclusion of two low-gradient run transects is also inappropriate, based on the habitat mapping conducted by BEAK. The habitat mapping indicates that no low-gradient run habitat is available in the reach, yet these two transects received a weighting of 30 percent in the lower Cloquet instream flow model (see Vol. VI, App. E-7, pp. 23 and 41). Inclusion of low gradient transects at the lower Cloquet site, if we are to be consistent with the MP/BEAK stance on the Upper Cloquet, is a gross over-representation of low velocity habitat in a high velocity site.

BEAK divided the St. Louis study location into two parts based on slope and habitat characteristics (high gradient: transects 1-6, riffles and fast runs; low gradient; transects 7 & 8, slow runs). All species were examined at both locations. This division of study locations into fast water and slow water and the placing all species, regardless of habitat preference, into each subdivision of a study site is inappropriate. Weighting factors of fifty percent were given to transects 7 and 8 at the lower gradient site. These transects contained water depths between 5 and 10 feet and velocities below 1 foot per second (0.6 fps). Applying riffle species to these transects results in very small amounts of actual habitat, which is masked by the normalization step, critical to the Leonard and Orth (1988) approach.

In summary, re-evaluation of weighting and representative analysis is essential to ensure accurate study results. The existing work by MP/BEAK is unacceptable to the MDNR. The following discussion is provided in further support of our position on these issues.”

RIFFLES AS CRITICAL HABITAT

A discussion of our view of riffles as critical habitat was contained in a letter dated March 29, 1990 providing the Department’s comments on the Final Study Plan (January 1990). We feel that negating riffle and any other habitats through weighting factors is totally inappropriate. The following review is presented in support of the Department’s view of riffles as “critical habitat”, particularly when they are scarce, as in the case of the Upper Cloquet Study Reach.

a) Definition of critical or unique reaches

A definition of critical reaches, which we accept, is as follows:

“Critical reaches are portions of rivers containing a particular type of microhabitat that is absolutely essential for the completion of one or more life stages of a species and absent or in very short supply in the representative reaches. Critical reaches are often associated with migration, spawning and incubation, and development of newly emerged young-of-the-year fish.” (Bovee 1982).

b) The Importance of Riffles

- Food Production. Velocity is a predominant characteristic of riffles and controls the occurrence and abundance, and hence the whole structure, of the animal community (Hynes 1970). Productive riffle areas are particularly affected by changes in flow, through flooding or drying (Briggs 1948; Neel 1963; Abbott and Morgan 1975). Riffles contain the majority of a river’s benthic invertebrates (Goldman and Horne 1983) and are consequently vital food production areas for fishes (Figures 1 & 2, Attachment 6). Schlosser (1987) found densities of benthic insects to be 6.2-7.9 times higher in riffles than in pools. For mayflies and caddisflies, which were the most frequently found invertebrates in smallmouth bass stomachs (Aadland et al. year or unpubl data?), Schlosser found densities to be 53.5 times higher in riffles than in pools. Riffles also contain the highest densities of fish in many streams (Schlosser 1982, Lobb and Orth 1991, Aadland et al. 1991). In the Cloquet River, Hassinger (1967) had high fish catches in pools below rapids but caught few or no fish in long straight sections of river channel.

- Fish reproduction. During the past four years, we have made habitat observations of nearly 40,000 fish of 70 different species in nine river systems, including the St. Louis River. For these 70 species, riffles are the most important habitat type for spawning. Of the obligate riverine species (those found almost exclusively in rivers), 80% are riffle spawners (Figure 3, Attachment 6). Most of the pool spawners are facultative riverine species, which can carry out their entire life cycle in lakes. These species are consequently less dependent on appropriate flows than the obligate riverine fishes. Of the fish sampled by Hassinger (1967) in the Cloquet River, 75% of the individuals were riffle spawning species. This is probably an underestimate since Hassinger sampled with a boat electroshocker, which is not

effective for sampling riffles. **The rarity of riffles in a river segment does not mean they are not important, but conversely, that they are critical.** For example, lake sturgeon spawning habitat in Dead Man's Rapids on the Little Fork River covers about as much area as an average living room. Radio tagged sturgeon migrated from as far as Lake of the Woods to this small area to spawn, traveling a distance of more than 100 miles.

- Sensitivity to flow. Under the low flow condition, riffle and raceway habitat is most constricted while moderately deep and deep pools are relatively unaffected (Figures 4 & 5, Attachment 6) (Curtis 1959, Kraft 1972). When flows approach zero, pools appear as a series of discontinuous ponds in the river channel. The channel between these pools is riffle or raceway habitat at normal flows that quickly diminishes as flows drop."

4. *Transect Placement*

Issue Definition

As I first heard from Ken Bovee on these matters: 'garbage in equals garbage out.' Data collection is all about objectives. Placement determines the data that will be collected. The key is representation, that is, how well do the data represent the channel? In other words, how representative is the transect location of the rest of the channel (not being measured)?

What's At Stake?

As a resource agency, your objective when sampling habitat is most likely to represent as much of the channel as possible. However, you should not assume that is the same objective as the consultant actually doing the field work. It may be that they want the transect data to reflect a limited and special situation (e.g., a hydraulic chute) and still be assumed to represent an entire stream reach. If successful, the effect then is to extrapolate an area of limited habitat value to an entire reach.

General Response

Make sure you personally are there (or a trusted representative) when transect headstakes are established, especially for bypassed reaches. Even if you are there for a general scoping meeting, but miss the specific headstake placement phase, you risk getting snookered (as we were on the Thomson bypassed reach).

Specific Response

"MP has stated that the channel is much smaller in the diverted sections (Thomson and Fond du Lac) than the undiverted reaches of the river and therefore the flows examined in the models are adequate. MP also contends that the amount of habitat available at optimum flows is a small percentage of the total area available at that flow. Based on this information, MP assumes that the fishery is of limited value in this segment.

In examining topographic maps of the study site location within the diverted segment below the Thomson dam, it appears the study location is within a confined channel segment and is not representative of a large proportion of the bypassed river segment. Transect profiles and a visual examination of the study site also indicate that this segment is a fairly deep bedrock channel. BEAK's habitat analysis of the study area shows habitat is best at low flows. MDNR contends that the study site is located in a section that is not truly representative of the diverted section. High flows in the river segment in which the study site is located produce extremely high velocities and depths

that are not typically suitable for the species examined. Topographic maps show that a substantial proportion of the bypassed river channel is wider and shallower than the site selected for the habitat analysis. It is quite possible that available habitat in these wider, shallower sections is greater at higher flows.

Transect placement on the diverted reach of the natural channel at the Fond du Lac site was also a concern to us. The transects do not appear to be adequately representing the significant riffle and shallow run habitat that exists directly downstream of the dam.

In summary, use of the model results may be skewed due to the limited range of flows modeled for certain months of the year and transect placement may have resulted in predicting conditions which are not representative of actual available habitat. MDNR recommendations should be viewed as representative of minimum conditions due to the limitations of the modeling and transect placement.”

5. Simulated Flow Range

Issue Definition

The PHABSIM models can only address flows within a range (0.4 times the lowest measured flow and 2.5 times the highest measured flow). Outside of this range you have no basis for drawing conclusions or making recommendations.

What's At Stake?

If the measured flows cover only the very lowest flows, your recommendations will be limited to minimum values as well. Watch for this issue, especially in bypassed reaches, where dedicated flows cut directly into power generation (the degree dependent on the upstream storage and operation plan) and dam regulation and power production can limit the flow you see.

General Response

Insist that the measured flows will cover the natural range of flows this channel experienced previously, even if you realize there is no way, politically, that you will see them implemented. You will firmly establish what it is you (the public) are losing – at the very least, an effective basis for other concessions.

Specific Response

“The highest flows simulated did not reflect natural, normal spring flow conditions in the Thomson and Fond du Lac diversions. Based on the hydrologic assessment performed by MDNR, the flow levels are less than the 80 percent exceedence flows for the spring spawning season at Thomson (April-June). At Fond Du Lac, the highest flows simulated did not attain the 80 percent exceedence flow for April or May. This is significant in that instream habitat continued to increase throughout the range simulated for these sites, and never reached a maximum level. Because high discharges, typical of spring flows, were not modeled, interpretation of results must be guarded. The shape of the habitat/discharge relationship is unknown at the higher discharges and peak habitat may occur well beyond the flow ranges that were modeled. Thus, when WUA/discharge curves are normalized, species which peak beyond the modeled range will show a peak occurring at flows lower than normal. Therefore, any evaluation based on the simulated flows will not take into consideration the total amount of habitat available during normal spring spawning.

The BEAK instream flow study indicates that available habitat is very limited in both diversion sections. We believe this is due, at least in part, to the flow range simulated in the model. The range of flows examined in the assessment reflects extremely low levels of naturally occurring flow for the St. Louis River. The BEAK community-based habitat optimization study analyzed habitat based on low flow conditions, rather than normal, natural historical flows. This limitation has necessitated making our preliminary flow recommendations based on incomplete data.

In summary, MP should revise its instream flow model to address a more realistic range of spring flows in the St. Louis River for the sites downstream of the Thomson Reservoir. MDNR should be involved in addressing this potentially significant gap in the analysis.”

6) *Derivation of Fisheries 'Minimum' Flows*

Issue Definition

Because the output of habitat flow relationships for many species life stages are often 'bell-shaped', that is, they increase to an optimum and then decrease again, they present an opportunity to play games with flow recommendations. The most common game is to use the graphical output to draw lines from higher flow and habitat values to 'equivalent' habitat levels at lower flows.

What's at Stake?

Habitat and habitat diversity. Recall that PHABSIM models what we know about these systems. What we don't know eclipses this information – just because the model results indicate things are okay – does this really make sense? Does it match the natural hydrology of the system that the organisms have evolved to? Unless there are extremely few fish and complete understanding of the stream's ecology play as few of these games as possible with the results. There is no free lunch.

General Response

Don't agree to anything the first time you hear it. Say you require time to discuss it with other agency experts and will get back to them by *such and such a date*. Discuss it in-house or with other biologists you respect and trust. Special approaches to select or develop flow recommendations should be openly and explicitly discussed between the resource agencies and the power company and their representatives and agreed to or shelved. If this type of thing is 'sprung' on you with short notice (no time for review), be suspicious. Typically, resource agencies can assume that special approaches being offered by the power company or their consultants will result in recommendations that favor power production.

Specific Response

“BEAK used a “flow window” procedure for deriving lower discharge values by equilibrating habitat levels to the mean monthly flows (Minnesota Power Instream Flow Study, Figure 4.1-1). We do not agree that this approach is suitable and believe it represents a deviation from the intended use of the approach outlined by Leonard and Orth (1988). The “flow window” approach used by BEAK was proposed by the National Ecology Research Center (NERC) to develop habitat-based flow recommendations for a single target species or species life stage. It assumes that similar habitat quantities at different flows will have the same effect on the species in question. However, a broader, community-level perspective is needed to protect stream resource values in warmwater streams (Orth 1987; Miller, et al. 1988). The Leonard and Orth method was developed to deal with multiple species in highly diverse warmwater streams. It attempts to simplify

the species selection and optimization process and is not a true composite, but rather a plot of all relevant species-life stage normalized WUA vs. discharge relationships.

The Leonard and Orth method was chosen by MDNR because it is a community-based approach driven by those species-life stages, which suffer the greatest loss of habitat over a specified alteration in flow. The suggested flows obtained by this method are a compromise among the WUA vs. discharge relationships for all species life stages, which are most habitat limited relative to their optimal flow. The window method used by BEAK was never agreed to by MDNR as a valid approach for use with the Leonard and Orth method. The assumption made by BEAK that its minimum flows provide the same habitat as the higher average monthly flows is not correct. Therefore, it is incorrect to imply that habitat for all species at 738 cfs (natural flow) is equivalent to habitat for these species at 22 cfs (BEAK “equivalent”), as BEAK has done for the Upper Cloquet site during June and July. In fact, the BEAK method would result in an almost complete loss of walleye spawning habitat (90-100% loss of habitat available under natural flows; 95-100% loss from MDNR recommended flows) in the Cloquet River. If habitat comparisons are to be made between natural flows and some “alternate” flow, the habitat of all relevant species-life stages must be examined-not only two or three as BEAK has done.”

7. Integration of Reservoir Needs (i.e., Reservoir Operations Modeling)

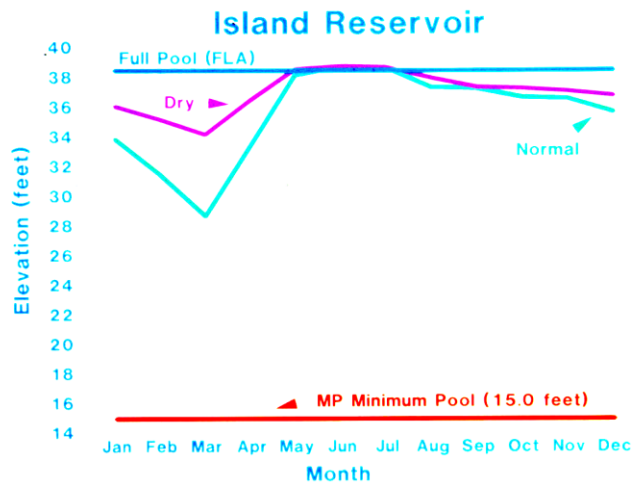
Issue Definition

As the state's fish and wildlife agency, MNDR sought to:

- a) restore and protect fish and wildlife resources on entire system (used habitat guild approach and also modeled for catfish, walleye, smallmouth bass): reservoirs, rivers and bypassed reaches
- b) restore and protect recreational opportunities on entire system (operation-related changes focused on canoeing in Cloquet River)
- c) as part of this process, we have been responsive to reservoir impacts; have limited drawdown substantially over previous license conditions (see figure below), established refill dates, prescribed dry year rule curves (rejected by the FERC) and allowed for secondary outflows (i.e., inflow) when dry conditions occur.

Reservoirs and hydropower dams, and associated resources are part of a river system, and changes on one part will affect the rest. To address impacts, the DNR's objectives were to:

- a) return to natural flow regime as much as possible:
 - a. no “no-flow” conditions below reservoirs
 - b. establish reservoir rule curves and drawdown limits, establish inter-annual (seasonal) and intra-annual (wet, normal, dry water years) flow regimes for outflows (see figure below),
 - c. designate ramping rates when moving between flow seasons to mimic natural changes as much as possible and avoid negative environmental impacts
- b) manage the reservoirs and rivers as a system, not focus on one component over another.



What's At Stake?

If there are storage reservoirs in the project you are reviewing, their operation will determine when you get water and how much. While it is true that except for evaporation loss, the reservoir will not change the total volume of water received in downstream channel(s) in an annual sense, they can and often do change when it is received. And in biology, timing is everything. In the northern quarter? half of the world, snowmelt and spring runoff dominate the hydrograph. Operation of storage reservoirs for power production can drastically change the shape of the hydrograph (see Figure 2 above), and hydrology drives these ecosystems.

General Response

Insist on a networked reservoir model as part of the analysis and final recommendation phase. Participate in the ???

Specific Response

"General Procedures and Criteria

On the tributary rivers, the Cloquet and Whiteface, our recommendations are two-fold, providing for reservoir elevations and providing for downstream river flows on a monthly basis. (*editors note: there were no gage data >> all hydrologic information had to be synthesized*) We furnish monthly reservoir elevation rule curves for both 'normal' and 'dry' inflows and matching outflows for the rivers. Our intention is to have MP operate the reservoirs within the bounds of these constraints, with actual outflows in any month determined by precipitation forecasts and reservoir elevations.

For the Thomson and Fond Du Lac bypassed reaches, we will be providing minimum flow regimes, derived to meet a variety of resource objectives. Our procedures and criteria were coordinated with MP and their consultant through the process of reconstructing the IFIM studies. The need to redo much of the consultant's work is in large part due to a lack of coordination between the original data collection and report stages of this IFIM study. Instream flows and associated reservoir elevations for 'normal' and 'dry' inflows (defined below under procedure 2.) were initially presented as

a MNDNR handout at the February 19, 1992 workshop meeting with MP and their consultants. The general procedure for developing final MNDNR recommendations for the tributaries was:

1. Instream flows for fisheries were established using the habitat guild approach outlined by Leonard and Orth (1988) and recommended for Minnesota instream flow recommendations by Aadland et al. (1989, 1991), Aadland (in press, 1993). In this approach, habitat discharge relationships for appropriate species life-stages in each season are modeled and the results are normalized, such that all habitat/discharge curves peak at a weighted useable area of one (1). To determine a specific flow recommendation, appropriate species life stages are plotted together, including habitat guild representatives and gamefish. As seen from the output in Appendix A2, different life stages need different flow levels. For some species life stages, habitat peaks at higher flows, and for others their habitat peaks at lower flows. The flow recommendation must represent a *compromise* between the needs of the most flow sensitive species. By adopting that flow where the high flow limited species intersects with the low flow limited species, we maximize the diversity of habitats available and optimize protection for the entire community. Keep in mind that as the raceway representative, adult shorthead redhorse, represent all species life stages preferring raceway habitat, not a single species life stage. The guild representatives and their associated habitat chosen for this study were: log perch adults, fast riffle; longnose dace adults, slow riffle; bluntnose minnow young-of-year, shallow pool; emerald shiner young-of-year, shallow pool; channel catfish juveniles, medium pool; shorthead redhorse adults, raceway.
2. Modeling of inflows, reservoir elevations, and outflows was undertaken using the model developed by Owen Caddy of the MNDNR. This networked reservoir model was an integral part of our flow recommendation process, particularly with regard to the storage reservoirs. The modeling process was incremental and iterative; outflows had to be changed to ensure reservoir refill under different inflow conditions and ensure maintenance of a recreational pool during summer. 'Normal' reservoir inflow conditions were modeled using the 50% exceedence flows developed from the MNDNR hydrologic data. 'Dry' reservoir inflow conditions were modeled using the 80% exceedence flows developed from the same data set. A run was considered successful when the criteria was met (e.g., refill by June 1) for two consecutive years under the model inflows (e.g., two consecutive and complete years of 80% exceedence flows for inflow to the reservoir). Precedence for defining 'dry' hydrologic conditions as we have done can be found in the IF201Manual for 'Problem Solving with IFIM', prepared by the National Ecology Research Center, Fort Collins, Colorado. To our knowledge, there have been no objections to using these conventions;"

. . . .

"As stated in the Results section, MNDNR developed a reservoir model that networked the St. Louis River hydro system together and, using the simulated hydrology and the IFIM-derived fisheries recommendations as input, developed final recommendations that bracketed hydrologic possibilities and still met resource concerns. A more detailed discussion of the MNDNR procedure and criteria used to guide our recommendation process can be found in the METHODS section, pages 3 through 5. MNDNR directly considered different inflow levels and their effects on reservoir elevations and subsequent dam outflows for the rivers.

MP took a different tack in modeling reservoirs and instream flow requirements. According to MP, specific instream flow needs for habitat were derived in three steps. First mean monthly flows, under natural conditions, were estimated for each study site. Second, the composited habitat-discharge relationships for each study site were used to determine the monthly habitat levels that would be available under the natural, unregulated river flow conditions. Third, the composited habitat-discharge relationships were used to find the lowest flow in each month that would provide the same or more habitat as available under natural, unregulated flow conditions. MP considered these resultant flows as the instream flow needs for habitat, but additionally, evaluated them at each site relative to the effects or constraints on MP operations.

It is obvious that the differences in approach outlined above, can lead to different final recommendations, in fact, it would be surprising if they did not. We contend that it is duplicitous to assess instream flow needs while simultaneously factoring in off-stream (reservoir storage, power production) demands. Competing uses of water should be factored separately, to allow full consideration and appreciation of the values to be lost or gained on both sides of the equation. “

SEE APPENDIX B FOR A MORE COMPLETE GRAPHICAL SUMMARY OF RESERVOIR OPERATION RECOMMENDATIONS

8. *Habitat Time Series*

Issue Definition

What's At Stake?

General Response

Specific Response

I like your caution to take your time. Our approach is to say we'll take it home, digest it, and develop a set of flow recommendations that are then what we would like. That gives us something to compare other offers to. Of course, after that, the games begin.

1. Management Goal

Great statement: "You will be held to whatever you come up with * for good or ill." That should be drilled into everyone re: management goals.

It may be worthwhile to have more of a discussion about the "minimum" flow concept in relation to incremental changes in flow and habitat. One of my pet gripes is the phrase instream flow "needs" when there is seldom a clear-cut threshold implied by "need": if you are below the "minimum" "need" all is not necessarily lost and if you are above the "minimum" "need" you don't necessarily have "waste".

After your final point about "compromise among the needs of all species" it might be good to say that when in doubt this compromise should be guided by a natural hydrology template - someone else should have to justify deviating from what has always worked.

2. Species Selection and Phenology

Good coverage

See also Transect weighting - it is important to provide suitable WUA in suitable mesohabitats as well as at appropriate seasons. Don't worry too much about WUA for a riffle species in a pool, make sure you get the riffle species habitat in the riffle. Even though we know riffles have features (flow through the riffle) that aren't modeled by PHABSIM, we still know that riffle species prefer riffles and some of the reason may be something that is not modeled (see #6 below).

3. Transect Weighting

Your General Response is very important and right on target. Furthermore, it is valuable to be able to not only weight unique habitats, but to analyze them separately to ensure that potentially limiting habitat is not masked by large-scale trends in WUA. You get at this in your specific recommendation, but appear to stop short of explicitly saying "analyze unique transects (or parts of transects - e.g., one end) by themselves." Emphasize that any habitat should be evaluated for flow-sensitivity (not just riffles).

4. Transect placement

Good coverage.

5. Simulated flow range

I view the 0.4-2.5 x measured flows to be more of an expectation limit. I like to use other quality control indicators to determine how far I can actually extrapolate - VAFs, limits on stage relationships (I strongly prefer all transects tied to one benchmark to make sure water doesn't flow uphill at some flow), and various velocity indicators. For that reason I also prefer 3 sets of velocities for vel regression rather than some of the other algorithms. However, sometimes we make do, given other constraints.

6. Derivation of Fisheries "Minimum" Flows

I would argue that PHABSIM models only part of what we know about these systems.

7. Integration of reservoir needs (i.e., reservoir operations modeling)

Sounds reasonable.

8. Habitat time series

Habitat time series must be recognized as a partial analysis that may work for mobile life stages, but not for fixed life stages, such as eggs that are either buried in a redd or adhere to a surface.

If long-lasting life stages (e.g., adult smallmouth bass) have a single set of suitability criteria, it is not appropriate to compare WUA in winter at 1-5 C with WUA in summer at 15-25 C. It is not appropriate to assume that whichever is lowest is a level that WUA for the other season can be brought down to.

