US FWS-WELUT Quart. Activities Rept.
July - Sept. 85

INFORMATION AND TECHNOLOGY DEVELOPMENT

Technical Assistance Provided to Minnesota DNR on Management Systems (OTL)

During the fourth quarter, WELUT provided direct technical assistance to the Minnesota Department of Natural Resources (DNR) and its Division of Fish and Wildlife. A week was spent on site examining the department's capabilities to complete a successful planning project and helping scope the schedule for completing the project. In order to meet the objective of meshing with the department's biennial budget cycle, an ambitious planning schedule was laid out. It is anticipated that WELUT will be directly involved in assisting this project for approximately 2½ months during FY 86. The cost of WELUT's continuing participation is being shared between FWS Region 3 (Federal Aid) and the State.

HEP Technical Assistance Activities (HEPG)

Art Allen and Rick Schroeder of HEPG conducted a modeling workshop in Vicksburg, Mississippi, during the week of September 23. The product of the workshop was a model for use in water resource studies in the lower Mississippi River Valley.

Adrian Farmer, Pat Sousa, and Don Hansen delivered the Habitat Management Evaluation Methods (HMEM) program to the Central Arizona Project study team in Phoenix, Arizona, during the week of September 16. The study team used the program to simulate earlier studies performed for purposes of designing mitigation plans. A written critique of the program will be used by the HEP Group to further refine the program.

Mel Schamberger and Adrian Farmer spent three separate weeks in Washington, D.C., on a task force to review the HEP program. The task force prepared a report for presentation at the Habitat Resources (HR) Programmatic Meeting, scheduled for October in Houston, Texas.

The HEP Group is planning a Wildlife Management Methods Workshop for November 18-22, in Vicksburg, Mississippi. This workshop will bring together federal and state specialists, with knowledge of managing bottomland hardwoods for wildlife, to compile information on the potential use of easements and fee-title land purchases for mitigation. The wildlife management information developed in the workshop will be used to evaluate the cost-effectiveness of easements and fee acquisitions.

Instream Flow Technical Assistance (IF&ASG)

On August 12-13, Richard Fisher of IF&ASG met with staff from the FWS Phoenix ES Field Office, Arizona Game and Fish Department, U.S. Forest Service, and Bureau of Reclamation to review their cooperative efforts in scoping for a PHABSIM (Physical Habitat Simulation System) study on the Verde River and to assist in selecting study sites and determine field data needs and collection techniques. Subsequently, Clair Stalnaker attended a meeting held in Phoenix on August 30 with personnel from Arizona State University, Arizona Department

G&F, etc. re. problems & needs of habitat suitability curves

[1985]

GILA RIVER ADJUDICATION
Monthly (Bimonthly) Progress Report

Consultant: Robert J. Behnke

Time Period: July 10 - August 31

Accomplishments (Highlights): The enclosed annotated references are divided into three categories: methods and method testing, endangered species, and general.

The "methods" references reveal that the naive, simplistic faith in instream flow models and habitat quantification models is being shattered. I would point to the citations under "EA Engineering" (attack on statistical bases of models), "Larimore and Garrels" (how fish change habitat preferences from day to night), "Li and Schreck" (how habitat preferences change in species depending if they are allopatric (no other species) or sympatric (coexisting with other species), "Loar" (similar to Li and Schreck but with different species and limited to instream flow models), and "Sheppard and Johnson" (how species change habitat preference from June to October), as examples. The "Fausch, Karr, and Yant" reference pertains to a new assessment-monitoring tool using fishes -- the Index of Biotic Integrity, currently being fostered by EPA.

The endangered species references include a listing of introduction sites (in Salt R. drainage) of the endangered Gila topminnow (copies of tables and map included for Bill Warskow).

The "Propst, Marsh, and Minckley" reference contains a correction to my report of July 10 (this paper was received within days after completion of my report). The loach minnow, *Tiaroga cobitis*, was found in White River and E. Fk. White R. on Fort Apache Indian Reservation. The loach minnow was considered extinct in Salt R. drainage until this find. My personal communicant for my July 10 report mistakenly told me it was the spikedace, *Meda fulgida*, that had just been found in the White River.

Pertinent sections from the Federal Register containing definitions of "nonessential experimental" populations and proposal to introduce squawfish and woundfin into Salt R. drainage have been previously sent to Bill Warskow.

Only 80 of the "experimental" squawfish being raised at the Dexter, N.M. hatchery to be stocked in Arizona were alive on June 18 (of 85,000 in 1984).

REFERENCES ABSTRACTED CONCERNING METHODS AND TESTING OF METHODS

Annear, T. C., and A. L. Conder. 1984. Relative bias of several instream flow methods. N. Am.J. Fish Mgt. 4(4):531-539. Several methods were compared to predict fishery flows in several Wyoming rivers. The comparisons demonstrated which methods most consistently disagreed with model values (USFWS' IFIM among "worst").

Armour, C. L., R. J. Fisher, and J. W. Terrell. 1984. Comparison of the use of habitat evaluation procedures (HEP) and the instream flow incremental methodology (IFIM) in aquatic analysis. U.S. Fish and Wildlife Serv. FWS/OBS-84/11:30p. After many years of feuding, the HEP and IFIM (formerly IFG) groups of FWS have combined their efforts in attempt to complement each other (HEP models to not include flow parameters), but new emphasis admits that simplistic "canned" programs cannot be universally applied in all situations. FWS disclaimer points out that site-specific data will be necessary to modify their models for each local situation. All species "habitat suitability" models now published by USFWS contain both HEP and IFIM models.

EA Engineering, Science and Technology Inc. (no authors listed). 1985. Instream flow methodologies, research project 2194-2, draft report. Prepared for Electric Power Res. Inst., Palo Alto, CA. This massive document critiques many instream flow models, especially the USFWS IFIM model. Many problems with the models are delineated, especially the statistical basis on which suitability curves are derived.

Fausch, K. D., J. R. Karr, and P. R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Am. Fish. Soc. 113(1):39-55. The Index of Biotic Integrity (IBI) was developed to assess and monitor water quality by use of fishes -- no. of species, proportion of omnivores, insectivores, predators, and certain indicator species to derive a metric. The IBI is currently a "hot item" with EPA. One of my students is working on EPA-IBI project in Corvallis, OR, and I am currently supervising another graduate student testing and fine-tuning the IBI for Colorado streams.

Hamilton, K., and E. P. Bergersen. 1984. Methods to estimate aquatic habitat variables. Prepared by Colo. Coop. Fish. Res. Unit for Bur. Recl. Engin. and Res. Cent., Denver. This manual is more than a simplistic review of aquatic sampling methods; it contains such gems of wisdom as: "methodology is the last refuge of the sterile mind" and "the probability of failure increases as the investigator's thinking becomes method rather than problem oriented."

Helm, W. T. 1983. Defining stream fish microhabitat requirements for water planning. Utah St. Univ. Cent. for Water Resources Res. Proj. B-177-UT.

Howard, C. D. D. (ed.). 1984. Instream flow workshop: interpretations of physical habitat analysis. Charles Howard and Asc. for Prov. Brit. Col. Ministry of Environ. This interesting document was sent to me by Mark DeHaven. It is one that 'slipped through the cracks' of my network to obtain such literature. This is a good synthesis and critique of techniques to relate flows to habitat criteria. Includes much unpublished and personal communication type information.

Larimore, R. W., and D. D. Garrels. 1985. Assessing habitats used by warmwater stream fishes. Fisheries 10(2):10-16. Demonstrates how habitat suitability curves differ according to sampling technique and how fish change "preferred habitat" from day to night -- that is, why simple, predetermined suitability curves for habitat variables (such as used in FWS' HEP and IFIM models) do not accurately represent biological reality.

Leather, S. A. and M. D. Enk. 1985. Cumulative effects of micro-hydro development on the fisheries of the Swan River drainage, Montana. Prepared for U.S. Dept. Energy, Bonneville Power Auth: 114p. Development of methods to evaluate impacts from dewatering and sedimentation.

Li, H. W. and C. B. Schreck. 1984. Formulation and validating models of habitat quality for cutthroat trout and coho salmon for Oregon's coastal streams. Ore. Coop. Fish. Res. Unit report to U.S.F.W.S., West. Energy and Land Use Team: 69p. Demonstrates changes in "habitat suitability" curves due to niche shifts when comparing a fish species with no other fishes (allopatric) in habitat and same species coexisting with another species (sympatric). Another example documenting inadequacy of USFWS suitability curves used in HEP and IFIM models.

Loar, J. M. (ed.). 1984. Application of habitat evaluation models in southern Appalachian trout streams. Oak Ridge Nat. Lab., prepared for U.S. Dept. Energy: 310p. Another detailed documentation of limitations of "canned" models to accurately associate habitat parameters with fish abundance and biomass. Also demonstrates shifts in "habitat suitability" when a species occurs alone and when it coexists with other species. A good critique of problems inherent in USFWS' IFIM models.

Mangum, F. A. 1984. The BCI (Biotic Conditioning Index), its development and use in evaluating aquatic ecosystems. Proc. 19th Ann. Meet. Colo.-Wyo. Chapt. Am. Fish. Soc.: 45-50. Describes a modified invertebrate diversity index for assessing and monitoring water quality, used by U.S. Forest Service Intermountain Region.

McConnell, W. J., E. P. Bergersen, and K. L. Williamson. 1984. Habitat suitability index models: a low level effort system for planned coolwater and coldwater reservoirs (revised). U.S.F.W.S. FWS/OBS-81/10: 62p.

Orth, D. J., R. N. Jones, and O. E. Maughan. 1982. Considerations in the development of curves for habitat suitability criteria. Pages 124-133 in Proc. Symp. on acquisition and utilization of aquatic habitat information. West. Div. Am. Fish. Soc.

Orth, D. J. and O. E. Maughan. 1982. Evaluation of the incremental methodology for recommending instream flows for fishes. Tran. Am. Fish. Soc. 111(4): 413-435. This, and above citation, essentially discuss why USFWS' IFIM models do not work very well.

Reiser, D. W., M. P. Ramsey, and T. R. Lambert. 1985. Review of flushing flow requirements in regulated streams. Bechtel Group Inc. Contract No. Z19-5-120-84, prepared for Pac. Gas and Electric Co. A good review of 'state-of-arts' methods used to determine flushing flows (typically the flow required to clean fish spawning substrates of sediment), and why optimum flushing flows (expressed as % of average daily flow) will change from one river to the next.

Sheppard, J. D., and J. H. Johnson. 1985. Probability of use for depth, velocity, and substrate by subyearling coho salmon and steelhead in Lake Ontario tributary streams. N.Am. J. Fish Mgt. 5 (2B):277-282. Demonstrates significant differences in "preferences" for these environmental components between fishes sampled in June and October. Also, both the June and October "use" curves differ from the curves of the USFWS' IFIM models for these species.

Shirvell, C. S. and R. G. Dungey. 1983. Microhabitats chosen by brown trout for feeding and spawning in rivers. Trans. Am. Fish. Soc. 112(3):355-367.

Terrell, J. W. (ed.). 1984. Proceedings of a workshop on fish habitat suitability index models. U.S.F.W.S., West. Energy and Land Use Team Biol. Rep. 85(6):393p. Some case histories documenting problems with USFWS habitat suitability models -- the lack of agreement between what is found in nature and what models predict. Essentially, admittance by USFWS people that they recognize that serious problems exist with their models.

REFERENCES CONCERNING ENDANGERED SPECIES

Brooks, J. E. 1984 (?). Factors affecting the success of Gila topminnow (Poeciliopsis occidentalis) introductions on four Arizona National Forests. Prepared for U.S.F.W.S. Office of Endangered Species, Albuquerque: 43p. Documents 64 sites stocked with Gila topminnow in 1982 and 24 sites stocked in 1983. It is not stated if these introductions were made under the 1982 End. Sp. Act ammendment for "nonessential experimental populations" only that they were made under a memorandum of understanding between USFWS, USFS, and Ariz. Game and Fish Dept. Because the introduction sites are tiny seeps, cattle tanks, etc. I do not envision any problem with adjudication process even if sites are federally protected. Tables and maps of sites will be enclosed for Bill Warskow for information storage.

Propst, D. L., P. C. Marsh, and W. L. Minckley. 1985 (July 5). Arizona survey for spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis): Fort Apache and San Carlos Apache Indian reservations and Eagle Creek, 1985. Prepared for USFWS Office of End. Sp., Albuquerque: 8 p.

This report was received a few days after completion of my report (July 10) "Information base concerning Salt River fishes". In my report I stated that the loach minnow was presently not known in Salt River drainage. I also gave a recent personal communication that spikedace had just been found in White R. The report by Propst et al. corrects my report of July 10. It was the loach minnow, not spikedace, that was found in the East Fork of the White River and in a short reach of the mainstem White River just downstream from confluence of North and East forks. Thus, the loach minnow is now documented in Salt R. drainage (on Fort Apache Reservation) and I expect USFWS will propose to include the sites where species were found as "critical habitat" as ammendment to the proposed listing of loach minnow as a threatened species.

I obtained copies of pertinent pages of Federal Register, vol. 49, no. 70 with explanation of "nonessential experimental populations" and proposal to stock squawfish and woundfin into Gila R. basin of Arizona. Vol. 49(96), contains proposed listing of desert pupfish (Cyprinodon macularius) as an endangered species. The only 'critical habitat' proposed for Arizona is Quitobaquito Spring, Organ Pipe Cactus National Monument. Vol. 50(117) contains proposals for listing of spikedace and loach minnow as threatened species. Critical habitat proposed for spikedace includes the lower mile of Sycamore Creek and, continuously, the Verde River upstream to Sullivan Lake. The loach minnow was unknown in Salt River drainage at time of proposal so no critical habitat was proposed. As discussed above, the recent finding of loach minnow in E. Fk. White River and in White River will probably result in these sites being proposed as critical habitat. The pertinent information from these documents has been previously copied and sent to Bill Warskow for information storage.

I noted in the "Endangered Species Technical Bull", 1985 vol. 10 no. 6, that the Little Colorado River spinedace, Lepidomeda vittata, has been proposed for listing as a threatened species. This species is found only in Little Colorado drainage. Critical habitat proposed includes 44 miles of E. Clear Creek, Chevelon Creek and Nutrioso Creek (proposal in May 22 issue of Fed. Reg.).

A note in End. Sp. Tech. Bull. 10(7) makes it doubtful that the "nonessential experimental" squawfish will be sotcked this year into Salt and Verde rivers as planned. In 1984, 85,000 baby squawfish were stocked into a pond at the Dexter, N.M., fish hatchery to rear as "nonessential experimental" squawfish for the Arizona introductions. This spring only 400 were left and only 80 by June 18. Canibalism is blamed for their demise.

GENERAL REFERENCES

Gislason, J. C. 1985. Aquatic insect abundance in a regulated stream under fluctuating and stable diet flow patterns. N. Am. J. Fish Mgt. 5(1): 39-46. How different insect groups respond to fluctuating flows and dewatering.

Grabowski, S. J., S. D. Hiebert, and D. M. Lieberman. 1984. Potential for introductions of three species on nonnative fishes into central Arizona via the Central Airzona Project -- a literature review and analysis. U.S. Bur. Recl. Eng. and Res. Cent. REC-ERC-84-7:124p. Considers the possibility of transport of striped bass and blue tilapia from Lake Havasu and of white bass from Lake Pleasant to Granite Reef diversion and into Verde and Salt rivers and impoundments. Written similar to an environmental assessment in regards to potential impacts on present fisheries, bald eagles, etc.

GILA RIVER ADJUDICATION

Monthly Progress Report

Consultant: Robert J. Behnke

Time Period: to July 10

Accomplishments: Completed report on Salt River Fishes. Made personal contacts for most recent information on species listed or proposed for listing under Endangered Species Act and current activities regarding Salt River fishery studies. Compiled and abstracted literature and unpublished pertinent reports regarding fishes, fisheries, environmental assessment and monitoring methodologies, mitigation and enhancement strategies and techniques.

Problems identified: My report identifies fish species of Salt River that are listed or proposed for listing under the Endangered Species Act, and other species of "special concern" -- fishes that may raise issues for adjudication process.

New developments: Two species recently proposed for listing under Endangered Species Act (June 1985 -- see report).

Anticipated goals: Continue to update information re. fishes, endangered species, assessment and monitoring methodologies, and await notification to proceed with next report critiquing current methodologies for environmental assessment, monitoring, mitigation and enhancement measures.

OFFICE MEMO

TO:

Date

WELUT Quart. Rep. July - Sep. 85

FROM:

Aug. 12-13 Richard Fisher (IEG) w/ FWS Phoenix staff

SUBJECT:

& AZ. G.&F. - USFS - Bur Rec. - coop. efforts in

REMARKS:

scoping for PHABSIM study on Verde R. -

OFFICE MEMO

TO: USFWS WELUT **Date**

FROM: Resource Analysis Application Project. - ~~workshop~~ meeting. Vicksburg MI

SUBJECT: for 3rd workshop on "bottomlands hardwoods" - for EPA

REMARKS: to develop manual for defensible evaluations of hardwoods wetlands functions - & cumulative impact for 404 permits -

Scarnecchia, D.L. & E.P. Bergersen. 1986 Draft. Models of salmonid production and standing crop in Colorado's small streams.

OFFICE MEMO

TO: Assess, Monitor, Predict

Date

FROM:

SUBJECT: – water Quality (Chemical) factors. regime temp., O_2, nutrients, potential toxicity (heavy metals) – that influence fish. sp. composition, biomass, distribution, production)

change below dams
(temp.) – Glen Canyon. trout

REMARKS:

Au Sable NO_3
Arkansas – heavy metals limit age-growth

– Physical factors (Habitat) A. re flow regime (IFIM)
B. cover, depth, velocity substrate (microhabitat) ...'read a stream'

Habitat improvement work demonstrates biomass ↑ – no food
volume of pools
feeding stations

– Biological factors: A. Potential food – invert. index, etc. abundance, diversity
B. Interacting coexisting fish & vert. (birds, m. predators) species

overriding
Gila chub
Black R. – S. M. bass
razorback sucker – catfishes

all interact – effects of predation; competition.

*Should use direct cause-effect factors causing aggregation, biomass, production

SIX MONTH PROGRESS REPORT

July 1 - Dec. 31, 1985

Consultant: Robert J. Behnke

I believe it may be useful to utilize this progress report for review and comment- for review of what I have done, am doing, and will do to be sure that my efforts are conforming to the objectives and needs of the adjudication process.

I have worked with the assumptions that a basis of information on Salt River fishes with special emphasis on federally listed endangered and threatened species is necessary, and that this information should be continually updated. For this, I completed a report on the fishes in July, and I review and comment on recent activities and literature in my bimonthly reports.

Another basic assumption is that, at some point in the adjudication process, in association with claims for water, will be demands for habitat and flow evaluations and assessments to predict the consequences of a changing flow regime. The danger here is that the administrators making such demands do not understand that there is no 'quick fix' methodology that can accurately predict the response of aquatic organisms to a change in flow in a variety of situations. The human mind is susceptible to the "illusion of technique" which, in turn, can lead to the embracement of "mindless methodologies" in a naive faith that problems can be resolved. Objectivity and quantitativeness are confused with biological reality. This distinctiion must be recognized. A model can be developed; precise measurements made and the data analyzed in a computer. The output is completely quantitative and objective as expressed in such metrics as weighted useable area or a habitat suitability index, but it may lack any real predictive value -- it may be far off the target of biological reality-- interactions that determine a species distribution and abundance during all life stages cannot be accounted for in a model.

To alert the participants in the adjudication process to this problem I have reviewed and commented on current literature in the annotated bibliography section of my bimonthly reports. A comprehensive report summarizing my efforts on a critique of aquatic habitat evaluation methodologies will be completed in April.

To illustrate the thrust of my efforts on this subject I will utilize two papers cited in the annotated bibliography section of this bimonthly report. The point I will make is that it does not require formal education in biology or statistics to understand basic problems and limitations of habitat evaluation methodologies -- common sense is a more useful attribute.

Copies of pages explaining the "Index of Biotic Integrity" (cited under Karr et al. 1985) are enclosed. The IBI is a hot new item with EPA. Anyone involved in aquatic consulting work will be hearing more of IBI. It is simply a method for evaluating habitat or environmental quality by fish species associations. Making direct measurments (fish species and abundance) rather than indirect (habitat parameters) has merit, but for each geographic area with different fish species compositions, whole new sets of indices must be developed and tested. For example, the Salt River drainage lacks a key group (species of darters) and has no native sunfishes.

Pages are enclosed from Layher and Maughan 1985, relating channel catfish abundance to habitat variables. These authors have performed several studies of the USFWS instream flow methods and the HEP (habitat evaluation proceedures, using the habitat suitability index (HSI)).

They consistantly have found very little correlation between predicted and actual values. This paper illustrates both biological and statistical problems with habitat models. Figure 1 illustrates the ideal curve developed for a model of habitat suitability or weighted useable area -- a neat unimodal curve represents the abundance of catfish in relation to average depth of the stream. If all such curves were "ideal", prediction of catfish abundance (biomass) with habitat variables would be relatively accurate. More true - to - life; however, is the curve I have drawn based on the data in table 3 associating catfish biomass to total dissolved solids in the water. Note that there is no real correlation, but the statistical formula used to produce a curve from this data will indeed make a curve, with or without any relationship to biological reality--by "brute force" of statistical "strongarming", which is far removed from how catfish actually respond to "total dissolved solids" (essentially, they do not, within this range).

Putting all the habitat suitability indices together, results in fig. 2 of the article showing the relationship between predicted biomass (based on HSI) and the actual biomass. A regression line is drawn on the figure and some slight significance is reputed. However, there is no true correlation. A principal rule of regression analysis was ignored (when highest value is two or more times greater than the next highest value, it should not be included in the regression).

It may seem incredible that such an objective, quantitative study, using so many habitat variables, could not produce a model reflecting biological reality. Its predictive value is eseentially zero.

The authors correctly concluded that a "broad-niche" species such as channel catfish cannot be accurately represented on simple HSI curves, and that HSI method should be used only for planning and not decision making.

These two critiques of current literature are samples of my forthcoming report. I assume that many who will read the report are not professional biologists, and I want the material to be understandable to the nonprofessional. Please raise any questions and give me your comments at Jan. 22 meeting.

BIBLIOGRAPHY OF LITERATURE ABSTRACTED

SEPT. 1 - OCT. 31, 1985

Anonymous. 1985. A method for estimating the carrying capacity impacts to anadromous and resident fish in oligotrophic drainages in the intermountain West. U.S.F.W.S., Aquat. Syst. Group:64p.

This report details an ambitious scheme to assess all kinds of habitat variables in an attempt to produce a model to optimize fish production -- grandiose in scope but not in the thought processes that went into it.

Endangered Species Bulletin 10(8) (Aug. 1985).

Mentions that 1000 endangered Gila topminnows, Poeciliopsis occidentalis, were stocked at five BLM sites in Arizona. Reports first evidence of survival of stocked razorback suckers in Salt River drainage with find of young fish in Carrizo and Cedar creeks, Fort Apache Reservation (fish stocked in April).

Fenner, P., W. W. Brady, and D. R. Patton. 1985. Effects of regulated water flows on regeneration of Fremont cottonwood. Jour. Range Mgt. 38(2):135-138.

Discusses influence of regulated flows in Salt River on downstream riparian vegetation. Claims that changes in historical flow regime has suppressed regeneration of cottonwood trees.

Moyle, P. B. and D. M. Baltz. 1985. Microhabitat use by an assemblage of California stream fishes: developing criteria for instream flow determinations. Trans. Am. Fish. Soc. 114(5):695-704.

Documents why habitat assessment models rarely reflect biological reality due to interspecific interactions and local conditions so that what is documented in one locality cannot be validly applied to another.

Rinne, J. N. 1985. Physical habitat evaluation of small stream fishes: point or transect observation vs. capture methodologies. Jour. Freshwater Ecol. 3(1):121-132.

Discusses different methods of habitat assessment and methods for associating fishes with certain habitat variables. Discusses causes for errors inherent in the techniques.

Weber, J. (no date). Potentially productive habitat: quantifying the treaty reserved water right to instream flows. Prepared for Columbia River Inter. Tribal Fish. Comm: 46p. + 27 p. of legal case notes.

A document discussing Indian water rights based on court cases in attempt to lay a basis for flow claims for fisheries (based on "potentially productive habitat") similar to consumptive use claims based on potentially irrigable acres.

Wegner, D. L. 1980-83. A series of three reports: "The development of an aquatic mitigation plan for the Uinta River", "Stream habitat evaluation-ecosystem variability and model sensitivity", and "Engineering design of aquatic structures".

Mr. Wegner was biologist for USFWS Instream Flow Group (now employed by Bur. Reclamation). These papers were presented at various meetings and symposia. They are "unpublished" but reveal an awareness of some basic problems in instream flow habitat models that were apparent among the Instream Flow Group biologists several years ago.

A major symposium on "small hydropower and fisheries" was held in Denver, May, 1985. The proceedings ("in press") will include papers under the following subject headings:

I. Flow modification: biological response
II. Regional and agency perspective
III. Benefits and tradeoffs
IV. Flow modification: assessment techniques
V. Fish migration
VI. Policy issues
VII. Cumulative impacts
VIII. Siting and design considerations

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P.1

GILA RIVER ADJUDICATION

Bimonthly Progress Report

Consultant: Robert J. Behnke
Time Period: September 1 - October 31

Accomplishments: In addition to the expert witness seminar (Sept. 30, Oct. 1) I continued to make contacts and abstract literature ~~pertaining to~~ relevant to Salt River fishes, mitigation, monitoring, and habitat assessment and critique associated with water development projects, alteration of flow regimes, etc.

A bibliography of the literature ~~abstracted~~ abstracted during September and October is appended to this report. I would call attention to the following highlights for various interested persons associated with the adjudication.

1. The Western Energy and Land Use Team (WELUT) of the U.S. Fish and Wildlife Service initiated a memorandum on "Recent developments in legal and institutional affairs related to instream ~~flow~~ and wetland uses of water." This memorandum reviews recent WELUT activities and abstracts items from ~~news~~ releases and journals such as ~~:~~ Western Natural Resource Litigation Digest Commentary, ERCD(?), ERC(?), Texas Water, and Anadromous Fish Law Memo. Topics in this issue (2nd Sept. 16) include: The legal and institutional analysis model (LIAM, a computer model developed by WELUT) for "planning and negotiations"); ~~Reserved~~ instream flows in national forests; endangered species litigation and other litigations against federal agencies related to water and the environment.

I had my name placed on the mailing list for this memo (issued four times per year). Others who may wish to receive this memo should direct their requests to Berton L. Lamb, Cooperative Instream Flow Group, Creekside One, 2627 Redwing Rd., Fort Collins, CO 80526; (303) 226-9321.

2. I received a copy of "Notes from Indian Water

Invoice

M. Byron Lewis

B - Gila R. Adjudication

- Services
- Expenses

1985" from ERO. When I read it, I ~~realized~~ understood the significance of a puzzling title of a paper I received, "Potentially productive habitat: quantifying the treaty reserved water right to instream flow" (cited under Weber in bibliography). This paper was prepared for the Columbia River Inter-Tribal Fish Commission (CRITFC) and the paper is a "trail baloon" to establish a criterion for "Potentially Productive" fish habitat similar to "Potentially Irrigable Acres" -- how to base a claim for ~~water~~ more water than that of historical or current use.

3. In my July Information Base report on Salt River fishes I discussed the ~~massive stocking program of sto~~ program of stocking massive numbers of young razorback suckers into the Salt River drainage in recent years and that no indication of survival of any of the stocked fish ~~was~~ had been documented to date. The August, 1985, issue of the Endangered Species Bulletin stated that some of the young razorback suckers stocked in April were found this summer in Carrizo and Cedar creeks on the Fort Apache Reservation. This is the first evidence of survival after stocking.

4. Tim Martin (ERO) sent some references to me including one cited in bibliography under Fenner, Brady and Patton, which discusses modification in riparian vegetation (cottonwood trees) due to regulated ~~[illegible]~~ flows in the Salt River.

5. A reference I came across ~~[illegible]~~ in a USFWS report (Anon. 1985 in bibliography) was: Madsen, M.J. 1935. A biological survey of streams and lakes of Fort Apache and San Carlos Indian reservations. U.S. Bur. Fish. mimeo. 16 p. In the 1930's, the

③

U.S. Bur. Fish. (now USFWS) made biological surveys all over the country. Most of the reports were simply typewritten for file (unpublished). I now know that ~~such~~ a report exists for Fort Apache and can probably be obtained in case a situation arises where we want some documented evidence on the condition of the fisheries on the reservations in former times (50 years ago).

Future Work: I have begun to practice "key wording" as requested by Bill Warskow. I will submit a list to Bill in regards to ~~the~~ endangered and threatened species. It may take some practice runs until I get the hang of it. Mark DeHaven contacted me concerning ~~the~~ a critique and evaluation of habitat assessment methodologies ~~in~~ relation to instream flow. A completion date of ~~Ap~~ May-June 1986 was suggested.

I plan to attend Desert Fishes Council meeting in Death Valley, Nov. 14-16, where I will pick up latest personal communication type of information on Arizona fishes, endangered species, etc.

① BIBLIOGRAPHY OF LITERATURE ABSTRACTED SEPT. 1 - Oct. 31, 1985.

Anonymous. 1985. A method for estimating the carrying capacity impacts to anadromous and resident fish in oligotrophic drainages in the intermountain West. U.S.F.W.S., Aquat. Syst. Group: 64 p.
This report details an ambitious scheme to assess all kinds of habitat variables in an attempt to ~~model~~ produce a model to optimize fish production -- grandiose in scope but not in the thought processes that went into it.

Endangered Species Bulletin 10(8) (Aug. 1985).
Mentions that 1000 endangered Gila topminnows, Poeciliopsis occidentalis, were stocked at five BLM sites in Arizona. Reports first evidence of survival of stocked razorback suckers in Salt River drainage with find of young fish ~~that in~~ Carrizo and Cedar creeks, Fort Apache Reservation (fish stocked in April).

Fenner, P., W.W. Brady, and D.R. Patton. 1985. Effects of regulated water flows on regeneration of Fremont cottonwood. Jour. Range Mgt. 38(2): 135-138. Discusses influence of regulated flows in Salt River on downstream riparian vegetation. Claims that changes in historical flow regime has suppressed regeneration of cottonwood trees.

Moyle, P.B. and D.M. Baltz. 1985. Microhabitat use by an assemblage of California stream fishes: developing criteria for instream flow determinations. Trans. Am. Fish. Soc. 114(5): 695-704. Documents why habitat assessment models rarely reflect biological reality due to interspecific interactions and local conditions so that what is documented in one locality cannot be validly applied to another.

(2)

Rinne, J. N. 1985. Physical habitat evaluation of small stream fishes: point or transect observation vs. capture methodologies. Jour. Freshwater Ecol. 3(1): 121-132. Discusses different methods of habitat assessment and methods for associating fishes with certain habitat variables. Discusses causes for errors inherent in the techniques.

Weber, J. (no date). Potentially productive habitat: quantifying the treaty reserved water right to instream flows. Prepared for Columbia River Inter-Tribal Fish Comm: 46 p. + 27 p. of legal case notes. A document discussing Indian water rights based on court cases in attempt to lay a basis for flow claims for fisheries ~~for~~ based on "potentially productive habitat" similar to ~~water~~ consumptive use claims based on potentially irrigable ~~lands~~ acres.

Wegner, D. L. 1980-83. A series of three reports: "The development of an aquatic mitigation plan for the Uinta River", "Stream habitat evaluation - ecosystem variability and model sensitivity", and "Engineering design of aquatic structures". Mr. Wegner was biologist for US FWS Instream Flow Group (now employed by Bur. Reclamation). These papers were presented at various meetings and symposia. They ~~but~~ are "unpublished" but reveal an awareness of some basic problems in instream flow habitat models that was apparent among the Instream Flow Group biologists several years ago.

A major symposium on "small hydropower and fisheries" was held in Denver, ~~June~~ May 1985. The proceedings ("in press") will include papers under the following subject headings:

I Flow modification: biological response.

(3)

II Regional and agency perspective
III Benefits and tradeoffs
IV Flow modification: assessment techniques
V Fish migration
VI Policy issues
VII Cumulative impacts
VIII Siting and design considerations

GILA RIVER ADJUDICATION

Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: September 1 - October 31

Accomplishments: In addition to the expert witness seminar (Sept. 30, Oct. 1) I continued to make contacts and abstract literature relevant to Salt River fishes, mitigation, monitoring, and habitat assessment and critique associated with water development projects, alteration of flow regimes, etc.

A bibliography of the literature abstracted during September and October is appended to this report. I would call attention to the following highlights for various interested persons associated with the adjudication.

1. The Western Energy and Land Use Team (WELUT) of the U.S. Fish and Wildlife Service initiated a memorandum on "Recent developments in legal and institutional affairs related to instream and wetland uses of water." This memorandum reviews recent WELUT activities and abstracts items from news releases and journals such as a Western Natural Resource Litigation Digest Commentary, ERCD (?), ERC (?), Texas Water, and Anadromous Fish Law Memo. Topics in this issue (September 16) include: The legal and institutional analysis model (LIAM, a computer model developed by WELUT for "planning and negotiations"; reserved instream flows in national forests; endangered species litigation and other litigations against federal agencies related to water and the environment.

I had my name placed on the mailing list for this memo (issued four times per year). Others who may wish to receive this memo should direct their requests to Berton L. Lamb, Cooperative Instream Flow Group, Creekside One, 2627 Redwing Road, Fort Collins, CO 80526; (303) 226-9321.

2. I received a copy of "Notes from Indian Water 1985" from ERO. When I read it, I understood the significance of a puzzling title of a paper I received, "Potentially productive habitat: quantifying the treaty reserved water right to instream flow" (cited under Weber in bibliography). This paper was prepared for the Columbia River Inter-Tribal Fish Commission (CRITFC) and the paper is a "trial balloon" to establish a criterion for "Potentially Productive" fish habitat similar to "Potentially Irrigable Acres" -- how to base a claim for more water than that of historical or current use.

3. In my July Information Base report on Salt River fishes I discussed the program of stocking massive numbers of young razorback suckers into the Salt River drainage in recent years and that no indication of survival of any of the stocked fish had been documented to date. The August, 1985 issue of the Endangered Species Bulletin stated that some of the young razorback suckers stocked in April were found this summer in Carrizo and Cedar creeks on the Fort Apache Reservation. This is the first evidence of survival after stocking.

4. Tim Martin (ERO) sent some references to me including one cited in bibliography under Fenner, Brady and Patton, which discusses modification in riparian vegetation (cottonwood trees) due to regulated flows in the Salt River.

5. A reference I came across in the USFWS report (Anon. 1985 in bibliography) was: Madsen, J. J. 1935. A biological survey of streams and lakes of Fort Apache and San Carlos Indian reservations. U.S. Bur. Fish. Mimeo. 16p. In the 1930's, the U.S. Bur. Fish. (now USFWS) made biological surveys all over the country. Most ot the reports were simply typewritten for file (unpublished). I now know that a report exists for Fort Apache and can probably be obtained in case a situation arises where we want some documented evidence on the condition of the fisheries on the reservations in former times (50 years ago).

Future Work: I have begun to practice "key wording" as requested by Bill Warskow. I will submit a list to Bill in regards to endangered and threatened species. It may take some practice runs until I get the hang of it. Mark DeHaven contacted me concerning a critique and evaluation of habitat assessment methodologies in relation to instream flow. A completion date of May-June 1986 was suggested.

I plan to attend Desert Fishes Council meeting in Death Valley, Nov. 14-16, where I will pick up latest personal communication type of information on Arizona fishes, endangered species, etc.

GILA RIVER ADJUDICATION

Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: Oct 1 - December 31, 1985

<u>Accomplishments</u>: I attended the Dessert Fishes meeting in the Death Valley, November 14 - 16. At the meeting I learned of a recent activities regarding endangered and threatened fishes pertinent to the Salt River drainage from James Johnson, USFWS, and James Brooks, Ariz. Game and Fish Dept. (now employed by USFWS). Under the "monessential, experimental" category of endanger fish stocking, woundfin (<u>Plagopterus argentissimus</u>) were stocked into the hassayampa, Verde, and Tonts Creek. Squawfish (<u>Ptychocheilus lucius</u>) were stocked as follows: 296 age 4 fish of 12 - 16 inches were stocked into the Verde River on Aug. 28. Also, 30,000 fry (age 0) and 113 age 1 fish were stocked into the Salt River on this date. During the past five years more than 12 million razorback sucker fry and juvenile have been stocked in the Salt River drainage. No survival of stocked fish were found until this year (mentioned in last bimonthly report). A few additional reports of survival were received. It is interesting to note that sites were young razorback suckers have survived, such as E. Fk. White River and in White River, are sites predominated by native fish species (98% of E. Fk. and 97% of White River fishes, by number, are native species). In downstream areas dominated catfish, it was estimated that, based on catfish density and their food consumption, the catfish could consume 50,000 razorback suckers (up to 100mm) passing through a particular river section in a 48 hour period. This predation most likely explain the disappearance of most of the 12 million young razorback suckers that were stocked.

I continued to abstract literature pertinent to the adjudication, that were stocked.

I continued to abstract literature pertinent to the adjudication, especially in regards to critiques of instream flow and aquatic habitat assessments for a comprehensive report called for in work order. Annotated bibliography for current time period is appended. Six month progress report to illustrate basic problems with habitat models that attempt to quantitatively associate habitat (or flow) parameters to fish abudance.

Literature deemed useful for SRP files such as paper cited in last report relating decline in Cottonwood trees to flow regulation of Verde and Salt rivers, is xeroxed and sent to Bill Warskow. The Electric Power Research Institure (EPRI) will hold a conference in Californiz (Jan. 86) to discuss and critique state-of-the-arts flow - habitat methadologies and models. I can't attend but will receive report of the conference.

Future Work: Initiate habitat assessment methodology report. Attend Jam. 21 meeting in Denver.

They consistantly have found very little correlation between predicted and actual values. This paper illustrates both biological and statistical problems with habitat models. Figure 1 illustrates the ideal curve developed for a model of habitat suitability or weighted useable area -- a neat unimodal curve represents the abundance of catfish in relation to average depth of the stream. If all such curves were "ideal", prediction of catfish abundance (biomass) with habitat variables would be relatively accurate. More true - to - life; however, is the curve I have drawn based on the data in table 3 associating catfish biomass to total dissolved solids in the water. Note that there is no real correlation, but the statistical formula used to produce a curve from this data will indeed make a curve, with or without any relationship to biological reality--by "brute force" of statistical "strongarming", which is far removed from how catfish actually respond to "total dissolved solids" (essentially, they do not, within this range).

Putting all the habitat suitability indices together, results in fig. 2 of the article showing the relationship between predicted biomass (based on HSI) and the actual biomass. A regression line is drawn on the figure and some slight significance is reputed. However, there is no true correlation. A principal rule of regression analysis was ignored (when highest value is two or more times greater than the next highest value, it should not be included in the regression).

It may seem incredible that such an objective, quantitative study, using so many habitat variables, could not preoduce a model reflecting biological reality. Its predictive value is eseentially zero.

The authors correctly concluded that a "broad-niche" species such as channel catfish cannot be accurately represented on simple HSI curves, and that HSI method should be used only for planning and not decision making.

GILA RIVER ADJUDICATION

Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: Nov 1 - December 31, 1985

<u>Accomplishments</u>: I attended the Desert Fishes meeting in Death Valley, November 14 - 16. At the meeting I learned of recent activities regarding endangered and threatened fishes pertinent to the Salt River drainage from James Johnson, USFWS, and James Brooks, Ariz. Game and Fish Dept. (now employed by USFWS). Under the "nonessential, experimental" category of endangered fish stocking, woundfin (<u>Plagopterus argentissimus</u>) were stocked into the Hassayampa, Verde, and Tonto Creek. Squawfish (<u>Ptychocheilus lucius</u>) were stocked as follows: 296 age 4 fish of 12 - 16 inches were stocked into the Verde River on Aug. 28. Also, 30,000 fry (age 0) and 113 age 1 fish were stocked into the Salt River on this date. During the past five years more than 12 million razorback sucker fry and juvenile have been stocked in the Salt River drainage. No survival of stocked fish were found until this year (mentioned in last bimonthly report). A few additional reports of survival were received. It is interesting to note that sites were young razorback suckers have survived, such as E. Fk. White River and in White River, are sites predominated by native fish species (98% of E. Fk. and 97% of White River fishes, by number, are native species). In downstream areas dominated catfish, it was estimated that, based on catfish density and their food consumption, the catfish could consume 50,000 razorback suckers (up to 100mm) passing through a particular river section in a 48 hour period. This predation most likely explains the disappearance of most of the 12 million young razorback suckers

that were stocked.

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<u>Future</u> <u>Work</u>: Initiate habitat assessment methodology report. Attend Jan. 22 meeting in Denver.

BIBLIOGRAPHY OF LITERATURE ABSTRACTED

Nov. 1 - Dec. 31, 1985

Johnson, J. 1985. Restoring the Colorado squawfish to Arizona waters. USFWS Endangered Species Bull. 10(10) :9.

Discussed in present bimonthly report as communication from Johnson at Desert Fishes meeting.

Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses. First North American riparian conference; 1985 April 16-18; Tucson, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1985. 523p.

These proceedings include 105 papers and 12 poster presentations. Primary topics include: physical characteristics, hydrology, and ecology of riparian ecosystems; riparian resources: recreation, agriculture, wildlife, livestock use, fisheries, and amphibians and reptiles; multiple-use planning and management; legal and institutional needs; and riparian ecosystems in dryland zones of the world. A model Riparian Habitat Protection Statute is appended.

Keywords: Riparian habitats, endangered habitats, aquatic ecosystems.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1985. Assessment of biological integrity in running warers: a method and its rationale. Draft manuscript prepared for EPA workshop, Leesburg, VA, 14-16 May, 1975:106p

Essentially a promotion to sell the "Index of Biotic Integrity" (IBI) as a tool for aquatic assessment and monitoring to federal agencies. The IBI was briefly discussed in my Aug. 31 bibliography under Fausch, Karr, and Yant 1984. Persons involved in aquatic consulting work will hear more of IBI and should be aware of its rudiments. Enclosed *with 6 mo. progress rep. are copies of pages from this document for edification. The danger is that administrators in federal agencies, as weaknesses in current methodologies such as instream flow and habitat suitability indices become more and more apparant, will seek out new panaceas, of new, but inappropriate methodologies. In its present state, the IBI can not be used for monitoring or assessing the "biological integrity" of the Salt River. One of its major indicators, the darters (a group of about 150 species of small fishes) do not occur west of Continental Divide.

Layher, W.G. and O.E. Maughan. 1985. Relations between habitat variables and channel catfish populations in prairie streams. Trans. AM. Fish. Soc. 114(6) : 771-781.

An attempt to refine USFWS habitat suitability indices (HSI) with catfish abundance. I discuss this paper in appended six month progress report to illustratre problems of simplistic models accurately reflecting biological reality. The authors correctly conclude that HSI models are suitable only for planning level and should not be used for decision making.

Mandila, T. 1985. Apache's winter smallmouths. Field and Stream, Jan. 86: 106-107.

Discussion of good smallmouth bass fishing in Salt River reservoirs, with emphasis on Apache Lake. Other popular fishes for the angler include largemouth bass,yellow bass, redear sunfish, green sunfish, bluegill, crappie, channel catfish, and walleye (note that all the sport fishes of Salt River reservoirs are non-native species).

Minshall, G.W., K.W. Cummins, R.C. Petersen, C.E. Cushing, D.A. Bruns, J.R. Sedell, and R.L. Vannote, 1985. Developments in stream ecosystem theory. Can. Jour. Fish. Aquat. Sci. 42:1045-1055.

Discusses the basis for a funtional approach to understanding river ecosystems --"the river continuum concept"-- whereby invertebrates are grouped by feeding type and the relative proportion of each group in a particular river section.

Wesche, T.A., V.R. Hasfurther, W.A. Hubert, and Q.D. Skinner. 1985. Assessement of flushing flow recommendations in a steep, rough, regulated tributary. Univ. Wyoming Water Res. Cent., WWRC 85-2:17p.

Results of a study to evaluate the effectiveness of recommended flushing flows. The recommended flow (60 cfs) effectively transported sediment from high gradient stream sections, but not from low gradient sections.

Williams, J.E. and D.W. Sada. 1985. America's endangered species: increasing their protection under the Endangered Species Act. USFWS Endangered Species Tech. Bull. 10(11) : 8-14.

Mentions that the "final determination" of loach minnow and spike dace (Salt R. drainage) and the Little Colorado spinedace (Little Colo. drainage) as "threatened" is still "pending".

ORIGINAL INVOICE

Robert J. Behnke

3429 E. Prospect Rd.

Fort Collins, CO 80525

Jan. 3, 1986

Gila River Adjudication

To: Salt R. Project

M. Byron Lewis

Jennings, Strouss & Salmon

111 W. Monroe

Phoenix, AZ

Re: Services, Nov. 1 - Dec. 31.

Bimonthly report, Annotated bibliography, six month progress report.

Three days x $300/day..............................Total $900.00

R. Behnke

GILA RIVER ADJUDICATION

Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: Jan - Feb. 28, 1986

Accomplishments: Attended meeting Jan. 22, at Denver Athletic Club to be informed on recent events and of legal processes. Trip to SRP, Phoenix, Jan. 29 - Feb. 1 to review file data on Verde River flows and other pertienent information. Trip to Phoenix, Feb. 6,7, to observe Verde R., Ft. Mc Dowell Reservation and its fishery. Prepared report on flow variation in Verde River in relation to limitations for recreational fishery, pointing out that the effects any flow modification has on availability of fishes to bald eagles is likely to be of critical concern.

I continued to work on abstracting information on flow - habitat associations for planned report on the subject, but when it became apparant that flow - riparian vegetation, especially Cottonwood tree regeneration would be an issue, I reviewed literature on riparian communities in an attempt to better understand and integrate assessments of fishery - habitat flow data with riparian community - flow interpretation.

The appended annotated bibliography includess some of the key riparian citations I have used.

ANNOTATED BIBLIOGRAPHY
Jan. 1 - Feb. 28, 1986

Habitat and Endangered Species References

Fausch, K.D. and L.H. Schrader. 1986. Application of an index of biotic integrity to three Colorado front range streams. Prog. Rep. May 1985 - Jan. 1986.
A graduate thesis research project to study feasibility of adapting IBI methodology to regional conditions as a tool for monitoring and prediction of water quality and fish habitat (IBI discussed in last bimonthly report).

Scarnecchia, D.L. and E.P. Bergersen. 1986MS. Models of salmonid production and standing crop in Colorado's small streams.
Manuscript prepared for publication on research attempting to correlate flow - habitat variables in small streams with production and biomass of trout populations.

U.S.F.W.S. Endangered Species Bulletin. Jan. 1986, 10(1).
Mentions the newly formed "Desert Fishes Recovery Team" that will advise the FWS on fishes of the lower Colorado, Yaqui, and Gila river basins. Also mentioned was stocking of 3,000,000 razorback sucker and 117,000 squawfish from Dexter, N.M. hatchery in 1985.

Wilzbach, M.A. 1985. Relative roles of food abundance and cover in determining the habitat distribution of stream - dwelling cutthroat trout (Salmo clarki). Can. J. Fish. Aquat. Sci. 42:1668 - 1672.
Study to quantify relative importance of food vs. habitat (cover) as determinants of trout density.

Riparian References

Brown, D.E. 1982. Desert plants: Biotic communities of the American Southwest - United States and Mexico. Publ. by Uniz. Ariz. for Boyce Thompson Arboretum : 342 p. General overview on Southwestern plant communities including types of riparian communities.

Johnson, R.R. and D.A. Jones (eds.) 1977. Importance, preservation and management of riparian habitat. U.S. Forest Serv. Gen. Tech. Rep. RM - 43 : 217 p.
Pertinent papers include : "Vegetation structure and bird use in the lower Colorado River valley", and "A riparian case history: the Colorado River".

Johnson, R.R. and J.F. McCormick (eds.). 1978. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. Forest Serv. Gen. Tech. Rep. WO - 12 : 410p.
Pertinent papers include: "The relation of flood timing and duration to variation in bottomland hardwood forest community structure", and "Avian population responses to Salt Cedar along the lower Colorado River".

Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Ffolliet, and R.H. Hamre (eds.) 1985. Riparian ecosystems and their management : Reconciling conflicting uses. U.S. Forest Serv. Gen. Tech. Rep. RM - 120 : 523p.

Papers from the "First North American Riparian Conference" include: "Managing riparian vegetation and wildlife along the Colorado River: synthesis of data, predictive models and management", "Revegetating riparian trees in Southwestern floodplains", Avian use of xeroriparian ecosystems in the North American warm deserts", "The effects of streamflow modifications on the development of a riparian ecosystem.

McNatt, R.M., R.J. Hallock, and A.W. Anderson. 1980. Riparian habitat and instream flow studies, lower Verde River Fort McDowell Reservation, U.S. Fish and Wildlife Serv. Riparian Habitat Analysis Group, Abuquerque : 52p.

This report is discussed in my report on Verde R. fishery potential. A minimum flow of 200 cfs is recommended for the trout fishery and for Cottonweed trees, but the authors overlooked the fact the bald eagles nesting on the Reservation feed predominantly on carp.

Swanson G.A. (ed.) 1979. The mitigation symposium. U.S. Forest Serv. Gen. Tech. Rep. RM - 65 : 684p.

Includes, "Riparian revegetation: An approach to mitigating for a diasppearing habitat in the Southwest."

U.S.F.W.S., WELUT Quart. Rep. (1985) mentioned a "Third workshop on bottomlands hardwoods" to be held so that EPA can develop a manual for defensible evaluation of hardwoods - wetland functions and cumulative impacts for 404 permits.

RECREATIONAL FISHERY POTENTIAL OF THE VERDE RIVER ON THE FORT McDOWELL RESERVATION

Robert J. Behnke

February, 1986

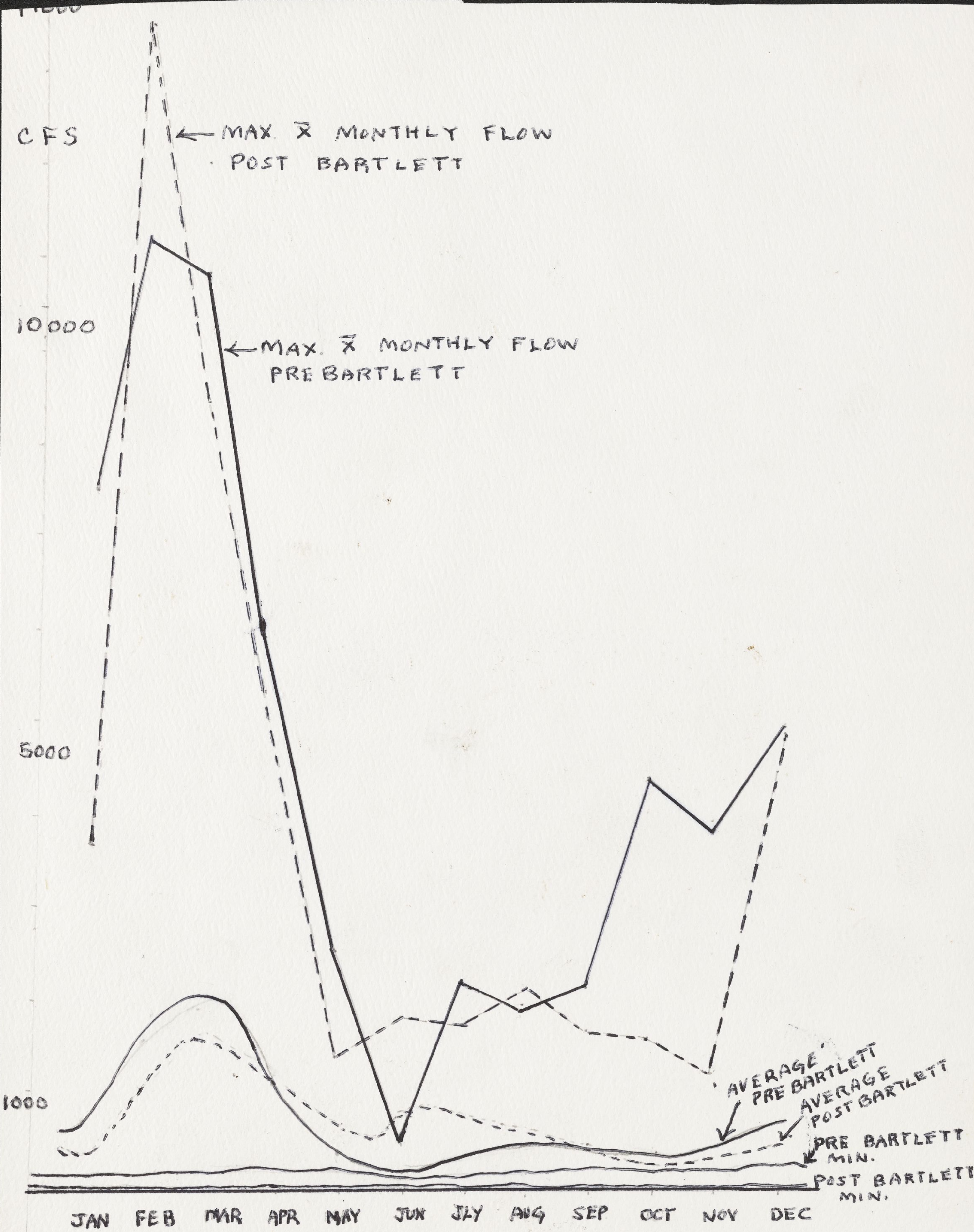
ABSTRACT

Only a few native fishes occur in the lower Verde River; most fishes are non-native species. A limited recreational fishery is maintained by stocking catchable-size hatchery rainbow trout during winter months. Because of limited reservoir storage capacity, the tremendous flow variability of the river has not dramatically changed from historic conditions. The great variation in intra and inter monthly flows and the insufficient volume of cold (hypolimnion) reservoir water during the warmest months, severely limits possibilities for maximizing recreational values of the fishery. Year round, cold water, tailwater fishery, such as found below Glen Canyon Dam in the Colorado River, appears impossible for the Verde River under present conditions. There are possibilities to increase the value of the present recreational fishery by flow regulation (ca. 100 to 600 cfs) during the winter months when trout are stocked, and by a recognition of the need for an increased emphasis on planning, management, and publicity to increase the sales of fishing permits. It should also be recognized, however, that fishes form the major food supply for eagles on the Reservation (and above Reservation), and increased minimum flows could possibly reduce the availability of fish to the eagles.

VERDE RIVER FLOW VARIATION

The potential for a recreational fishery in the Verde River is severely restrained by the enormous flow variation-- day to day, within a month, between months, and between years. This is due to the sporadic nature of precipitation patterns in the drainage basin. Figure 1 illustrates average, minimum and maximum monthly flows for about a 40 year period before Bartlett Dam and about 40 years after Bartlett Dam regulation. The enormous variability is obvious from the figure. Maximum mean monthly flows may exceed minimum values by more than 100 fold, and this range of variation has not significantly changed after river regulation because reservoir storage volume, although dampening the effects of intermediate to relatively high flows, is not sufficient to control flood events of great magnitude (40,000 - 50,000 + cfs). Typically, storage of water during the winter months, reduces river flow below Bartlett Dam in comparison to virgin flows and release of water to meet downstream demands during spring and summer months increases the flow above that of virgin conditions. This pattern of river regulation -- greatly reducing peak flows and increasing summer flows -- creates favorable fish habitat conditions and in other rivers has resulted in some of the nation's most famous trout fisheries such as the South Platte, Gunnison, and Frying Pan rivers in Colorado, the North Platte ("Miracle Mile"), Wyoming, BigHorn River, Montana, and the Colorado River below Lake Powell, Arizona. These fisheries also depend on an optimum temperature regime throughout most of the year, which, in turn, is dependent on great storage volumes of the reservoirs (much greater than the volume of Bartlett Reservoir).

Figure 1. Mean monthly flows for Verde River on Fort McDowell Reservation for pre and post Bartlett Dam periods (aproximately 40 years of data for each period), showing maximum, minimum, and average values for the periods. Since river regulation, average monthly flows have been generally reduced in the fall and winter and increeased during the spring and summer in comparison to historical flows. However, due to limited reservoir storage capacity, the tremendous flow variability on intramonthly, intermonthly, and interannual bases, that act to severely limit any recreational fishery potential, has not dramatically changed. Curves below 1000 cfs are exagerated (not drawn to scale) for ease of interpretation.



MAXIMUM, MINIMUM, AND AVERAGE MONTHLY FLOWS
VERDE RIVER, PRE AND POST BARTLETT DAM

The limited storage volume of Bartlett Reservoir cannot control major flood events and does not contain sufficient cold, hypolimnion water to maintain downstream water temperatures suitable for trout during the warmest months. In most years, the water temperatures in the Verde River below Bartlett Dam exceed the lethal limit for trout (ca. 78- 80 degrees) by May. Thus, under present conditions, a trout fishery is only possible during the cooler months, and must be based on a put-and-take stocking of hatchery fish. The most than can be accomplished from changes in flow regulation would be to establish goals for minimun and maximum flows during the trout fishing season that would best accomodate the anglers and increase sales of daily permits.

Table 1. Standard deviations of mean monthly flows in Verde River before and after Bartlett Dam.

	Pre	Post		Pre	Post		Pre	Post
Jan.	1047	352	May	138	208	Sept.	436	238
Feb.	1639	716	Jun	32	230	Oct.	314	187
Mar.	1708	1084	July	170	251	Nov.	445	138
Apr.	877	516	Aug	321	185	Dec.	1173	722

Table 1, comparing standard deviations of mean monthly flows for the pre and post Bartlett period, demonstrates that the average variability in mean monthly flows has been reduced for most months by river regulation, but monthly flow variation has been increased during May; June and July. The absolute magnitude of this variation (difference between minimum and maximum mean monthly flows, figure 1) has changed little, however.

Historically there has been great variation in the average daily flow within a given month (intramonthly variation). For example, July 1904, had a mean monthly flow of 729 cfs, but the average daily flow ranged from 32 to 6030 cfs. Flows in November, 1905, ranged from 301 to 61,500cfs for a mean monthly flow of 3432 cfs. Other preimpoundment examples of intramonthly variation include December, 1908: 310-51,600 cfs (3129); Jan. 1916: 525-53,400 (8231); and March, 1938: 338-59,700(4715). Exceptional intramonthly flow variations after river regulation by Bartlett Dam are: December, 1965: 0-28,700 cfs; December, 1966: 253-45,000 (2805); October, 1972: 124-45,600 (4194); March, 1978: 1130-65,100 (10,418); December, 1978 : 319-58,600 (4591); February, 1980: 8-58,800 (13,675).

Local flash floods cause great diurnal variations. For example the average daily flow of July 31, 1956, was 1020 cfs, but most of that was due to a peak discharge of 12,800 cfs at 5:30 P.M. With such inherent instability of flows modifying, rearranging, and impairing fish habitat, the recreational fishery potential of the Verde River is under severe constraints. The major inimical effect of river regulation on fish habitat concerns periods of very low flow or no flow. The lowest recorded minimum flow before Bartlett Dam was 29 cfs. After river regulation there have been numerous periods when no flow was released from Bartlett Dam; sometimes for days or weeks at a time, such as during the drought year of 1977 and during the period from September, 1980 to May, 1981, because of repair on the spillway.

If minimum (ca. 100 cfs) and maximum (ca. 600 cfs) flows could be established during the trout fishing season (ca. November - March), habitat condition for the stocked fish, and angler accessibility to the fishery would be greatly enhanced over virgin flow conditions.

FISHES AND FISHERY

Fishery surveys made in 1975 for the Orme Dam EIS found 16 species of fish in the Verde River below Bartlett Dam (same for Salt River below Stewart Mountain Dam). Only 4 of the 16 species are native to the Verde -- longfin dace, roundtail chub, desert sucker, and Sonora sucker (none of native fishes are endangered or threatened species). The most abudant species by numbers were: red shiner (2,812), desert sucker (1,196), and carp (690). The species representing the greatest biomass in the collection were: carp (1,143 pounds), desert sucker (581 pounds), and Sonora sucker (269 pounds). Channel catfish were represented in the collection by 264 specimens weighing 132 pounds. Catfish were probably underestimated because they are disproportionately difficult to collect unless special efforts are made to sample during the night. I point this out because channel catfish were the dominant prey utilized by bald eagles at the "Bartlett" nest site (Grabowski et al. 1984).

At the Bartlett nest site, 34.5% of all prey remains were identified as channel catfish, 23% as Sonoran sucker, and 3.6% as carp (bird and mammal prey made up most of the rest of the diet). At the "Fort McDowell" bald eagle nest site, catfish, sucker and carp made up 11.2%, 22.3%, and 33.3% respectively of the prey remains found.

Obviously, fish make up the bulk of the diet of the bald eagles living along the Verde River, and any proposed changes in flow that might influence the availability of fish to the eagles, is likely to be critically examined.

Although some permit revenue is derived by the tribe from fishermen fishing for catfish in spring and summer, most permits are sold to trout anglers during the winter months who pay (currently four dollars per day) to fish for stocked rainbow trout (McNatt et al. 1980). These authors provided few details on the Fort McDowell recreational fishery except to note that about 10,000 trout per year were stocked from November through March (average of 2000 per month), and the tribe gained about $3,000 to $3,500 per year by selling angling permits. It was also mentioned that the trout were supplied to the tribe by the U.S. Fish and Wildlife Service. If the tribe obtains its trout for stocking at no cost, then all permit sales are clear profit. However, much more than $3,500 per year would be necessary to make the stocking of 10,000 trout a cost effective operation.

On my survey of the fishery on Feb. 7, I noted that the trout being caught averaged 10-11 inches (about half pound each). Trout of this size are sold by private hatcheries for $2.00 to $2.50 per pound. Some anglers had caught limits of 10 fish (ca. 5 pounds). I counted eight anglers (assumed to have purchased permits) fishing above and below the highway bridge from about 10:30 to 11:A.M. I counted another eight anglers fishing upstream, near confluence of Sycamore Creek from about 3:00 to 3:30 P.M. Total permit sales may have been about 20 for Friday, Feb. 7. I interviewed most of the anglers to get some insights into the user group, their degree of satisfaction, preferences, and their assessment of the flow at the time -- too high, too low, or "about right".

The user group can be divided into three broad categories--"casual," "active," and "expert" anglers. "Casual" anglers mainly enjoy the outdoor experience and "catching a limit" is secondary. The paramont goal of the "active" angler is to catch a limit. The "expert" angler is more concerned with tackle and technique (fly fishermen) and many release most or all of the fish they catch. Most of the anglers I interviewed would be categorized in the "active" group. They fished with bait in deeper pools (mainly just above highway bridge). Some had caught limits of 10 fish. They were well - satisfied and thought the flow at the time was "just about right" (which I estimated to be about 300 cfs at the bridge). Two "expert" type of anglers fly fishing below the bridge thought the flows "too high" and "muddy" (the river was in process of clearing but had recently carried a heavy silt load as was evident from shoreline deposits). Other anglers, I interviewed in the afternoon, upstream near confluence of Sycamore Creek, told me they prefer this area because of fewer people and more room to enjoy the outdoors, even though they had been told that this area of the river was not stocked as heavily or as frequently as was the river near the highway bridge. I categorized these anglers as "casual". They expressed no preference or opinions on ideal flows. The flow here I estimated at about 500 cfs (Bartlett Dam had increased its release to 600+ cfs).

IDEAL FISHERY FLOWS

McNatt et al. (1980) recommended a minimum flow of 200 cfs for the Verde River on the McDowell Reservation, based on an analysis using instream flow incremental methodology (IFIM). Their analysis was made near "Rattlesnake Point". Their curve of weighted useable area (WUA) for adult rainbow trout is maximum at flows between 200 and 400 cfs with peak at about 250 cfs. The IFIM analysis is a simplistic representation of nature and it should not be considered that flows between 200 and 400 cfs as optimum for rainbow trout in the Verde River has been established as fact. From my own, rather cursory, examination of the river, however, I would agree that such flows are approximately correct in regards to trout habitat in most of the sections of the river. In large, deep pools, the trout would be little affected by large changes in flows, but angler dissatisfaction would likely arise from flows of less than about 100 cfs because the trout would be difficult to catch (too "spooky" in low, clear water), and flows in excess of about 600 cfs may make fishing more difficult for most anglers. Most of the river through the reservation consists of broad, relatively shallow channels. In such habitat, about 200 cfs may be necessary to provide sufficient depths, but with flows much in excess of 600 cfs the velocities in channel habitat may be too high for useable trout habitat. If large boulders were contained in the channel sections, they would create refuge areas for trout during high and low flows, and thus maintain useable habitat over a great range of flows. I did not observe large boulders (ca. one ton size) in any area of the Verde River. Evidently, boulder "recruitment" into the main channel is not occurring from flash floods in Camp Creek or Sycamore Creek.

The lack of large boulders in the Verde River suggests a possibility for habitat improvement by placing boulders in the river channel in selected sections. Undoubtedly, boulder placement would improve trout habitat (capacity of the river to retain more of the hatchery trout), but I doubt they could remain in place during extremely high flows (ca, 40,000 cfs), which occur, on average, every 10 years or less. Other types of habitat improvements that might be considered are log jams or brush piles, constructed on shore and anchored in the channel at selected sites, which could be added each year. Overall, the possibilities of significant habitat improvement in the river are limited due to the unpredictable high flows.

A possibility that could be examined, is the extension of the trout season by one or two months, into April and May. This would depend entirely on the possibility of extending the cold, hypoliminion volume in Bartlett Reservoir, by manipulation of winter flows (maintaing them at relatively low levels ca. 200 cfs) so that cold, hypoliminion water would be available for release during April and perhaps May.

Temperatures from about 50 degrees to 65 degrees are ideal for trout, but during days when air temperatures exceed 100 degrees, water released from Bartlett Dam will be exposed to rapid warming, unless the release volume is large (ca. 500-600 cfs). McNatt et al. (1980) cite an example of 58 degree water released from Bartlett Dam at 47cfs, warming to 83 degrees by the time it reached the Reservation boundary, 10 miles downstream. Thus, if the trout season is to be extended in comparison to past years, the flow volume from Bartlett Dam would have to be increased when air temperatures rise to summer levels. This strategy would work only as long as cold, hypolimnion water was available in Bartlett Reservoir (data for most years I examined, indicate hypolimnion is exhausted in May). The U.S. Fish and Wildlife Service has developed a flow-temperature model that can predict downstream temperature changes in relation to flow volume and air temperature, I would point out that the Verde River is subjected to intense solar radiation. The channel is mainly wide and relatively shallow and there is virtually no shade on the water.

TRIBAL INVOLVEMENT

My impression of the fishery is that the tribe operates it as a "low profile" program with little consideration for more intensive management designed to maximize the sale of permits. There are no signs or notices posted explaining or advertising the fishery. A daily permit is purchased at the gas station at the highway but there is no way to know this unless inquiries are made. An employee at the gas station told me that the trout are delivered from the White River hatchery (White River Apache Reservation. The hatchery may now be operated by the BIA), but he didn't know how many are stocked each year, how frequently, how many permits are sold, etc.

With the proximity to the Phoenix metropolitan area, the pleasant surroundings, an access to about 10 miles of river, this fishery could attract much heavier use (one angler told me it was one of his best kept fishing secrets). If greater angler use is developed, however, more intensive mamagement and planning would be needed.

Together with any plans to modify flows to benefit the fishery, a detailed stocking schedule should be worked out, limits reduced from 10 to no more than five trout per day, and consideration of a catch- and - release (no-kill) area to attract more of the "expert" clientel. Also, overnight camping areas and recreational vehicle camping sites might be considered as an adjunct to recreational fishing to generate more income. With greater emphasis on planning and management, the recreational fishery could be greatly expanded with increased revenue to the tribe.

EAGLE CONSIDERATIONS

As previously mentioned, bald eagles living on the Reservation and on the river above the Reservation depend on fish for the bulk of their food supply. Although a noble bird, the eagle is really not the most effective predator. In many areas, it obtains fish by bullying more specialized fish-eating birds to give up their prey and by scaveging on carcasses. When capturing fish, the eagle is restricted mainly to clear, shallow water, such as backwater pools. The high incidence of channel catfish in their diet at the "Bartlett" site is surprising to me because catfish prefer deep water and are nocturnally active. I could find no information on where and how the eagles obtain their fish from the Verde River, and until this is known, nothing of substance can be said about possible impacts to the eagle from a change in flows. The logical point that could be made is that highly fluctuating flows, filling backwaters on high flows and isolating such waters on low flows, are important to ensure the eagles with an adequate supply of fish.

It is not likely that the eagles can be ignored in any considerations concerning a modified flow regime. McNatt et al. (i980) stated: " sustained flows of 200-300 cfs, besides providing increased trout habitat, would most likely reduce the abundance of carp which prefer quiet water and deep holes." If this is true, then such flows would be negative to the eagles on the Reservation because, based on prey remains at their nest site, carp made up the largest single component in their diet. Also, implicit in considerations to increase angler use on the Reservation is the question of how will increased human activity on the river affect the eagles?

LITERATURE CITED

Grabowski, S.J., S.D. Hiebert, and D.M. Lieberman, 1984. Potential for the introduction of three species of nonnative fishes into central Arizona via the Central Arizona Project - A literature review. U.S. Bur. Recl. REC-ERC-84-7:124p.

McNatt,R.M., R.J.Hallock, and A.W. Anderson. 1980. Riparian habitat and instream flow studies lower Verde River, Fort McDowell Reservation, Arizona. U.S. Fish, Wildlife Service, Riparian Habitat Analysis Group, Albuquerque, N.M. 52p.

ORIGINAL INVOICE
Feb. 28,1986

Robert J. Behnke

3429 East Prospect Rd.

Fort Collins, CO 80525

GILA RIVER ADJUDICATION

To: SRP Mr. Byron Lewis

Jennings, Strouss, and Salmon

111 West Monroe

Phoenix, AZ 85003-1791

Re: Services and expenses Jan. 1 - Feb. 28, 1986

Jan. 22: meeting Denver Athletic Club

Personal vehicle 133 miles x .25/mi...................$33.25

parking.................. 2.25

Jan. 29,30,31,Feb 1. S.R.P., Phoenix for meeting and examination of flow records ans associated data

air travel.................$138.00

motel................. 102.66

meals................. 40.00

Feb. 6,7. S.R.P. Phoenix for observations on Verde R., Ft. McDowell Reservation

air travel.................$138.00

motel................. 42.66

meals................. 12.00

Analysis and synthesis of data for report on Verde River flows and fishjery potential and for bimonthly report

9.5 days x $300/day..........$2850.00
TOTAL...............$3358.82

GILA RIVER ADJUDICATION

"Trimonthly" Progress Report

Consultant: Robert J. Behnke

Time Period: March 1 - May 31, 1986

Accomplishments: Virtually all of my time devoted to the Gila River Adjudication during this period was devoted to completion of a report: "Critique of Insteam Flow Methodologies". I assume that I will not be on hand for all phases of discussion - negotiations in regards to environmental impact analysis. The objective of my critique is to provide SRP personnel with some basic understanding of limitations of any type of habitat model so that funds are not wasted on meaningless work. I will submit a "catch-up" monthly report, June 30, which will review literature and information abstracted since February and will contain some addenda information for the flow methodology critique.

	Dick Morgan	USFWS (N.M.)	505-841-4600
	Paul Barrett	" Phx	241-2493
Biologists Both are Knowledgeable	Marty Jakle	USBR	
	Jim Burton	Az. G&F	942-3000

The two gentlemen on the bottom of the list are both very familiar with the entire Verde system, habitat, species, flow records, etc.

ORIGINAL INVOICE

June 2, 1986

Robert J. Behnke
3429 East Prospect Rd.
Fort Collins, CO 80525

To: SRP, Mr. M. Byron Lewis
Jennings, Strouss, and Salmon
111 West Monroe
Phoenix, AZ 805003-1791

Re: Service and expenses March 1 - May 30, 1986.

Review and synthesis of literature and completion of report : Critique of Instream Flow Methodologies.

12 days x $300/days..................................	$3600.00
typing, xeroxing......................................	$ 47.78
total	$3647.78

Robert J Behnke

GILA RIVER ADJUDICATION
Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: July 1 - Aug. 31, 1986

Accomplishments: During this period I communicated with several biologists concerning my report on the critique of Instream Flow Methodologies. Enclosed as attachment 1 is a copy of a letter to Barry Nehring which further elaborates on some points developed in my critique report. I believe this letter may be a useful addition to the critique because it emphasizes the need for the human element of knowledge and intelligent integration. This matter is the subject of a recent book by Theodore Roszak, " The Cult of Information". Roszak makes the following points: " There is a vital distinction between what machines do when they process information and what minds do when they think. Thinking and information processing are not the same." "There is a danger of replacing thought with data because a blizzard of data masquerades as knowledge." " Information is discrete bundles of facts, never the substance of thought -- there is a danger of substituting information for understanding." "Computers tend to spellbind their users."

It occurred to me that in the critique, I did not make a distinction between the USFWS' IFIM and HEP proceedures of habitat assessment and prediction. I used examples from both IFIM and HEP to demonstrate the limitations of any predictive habitat model. Enclosed is FWS/OBS-84/11 publication that compares and delineates the differences between HEP and IFIM for aquatic analyses. Essentially, HEP would be used when a nonflow parameter might be changed such as pH, turbidity, etc. Both HEP and IFIM use HSI (Habitat Suitability Index curves) but the quantitative output of HEP is "Habitat Units" (HU), whereas; the IFIM output is "Weighted Useable Area" (WUA). Both lack predictive accuracy of relating HSI values to biomass or abundance of fish. Note in table 1, page 6, of enclosed publication, this lack of association of HU or WUA with fish biomass or abundance is clearly admitted.

The literature reviewed during this period is appended.

On August 28, during a recent trip to California, I met with biologists of Pacific Gas and Electric (PGE) at their office in San Ramon to discuss the latest developments and problems of current instream flow studies and methodologies in California. When I review recent PGE reports, I will summarize the results in my next bimonthly report.

ANNOTATED LITERATURE REVIEW

JULY - AUG., 1986

First I thank Bill Warskow for calling my attention to the June issue of the Water Resources Bulletin, vol. 22 no. 3. This issue contains seven papers which comprise a monograph, "Engineering considerations in small stream management". I read these papers and abstracted pertinent data and information for my files. A summary of this "monograph" emphasizes a point made in my instream flow critique, to the effect that stream channels can be highly unstable through time. Thus, computer simulation of habitat based on present channel configurations to predict changes in the future from a changing flow regime will lack validity if the channel configuration changes.

Chart, T. 1986. A review of stream regulation in North America. This report was written by a C.S.U. graduate student as part of his preliminary or qualifying graduate examination and reviews the physical, chemical, and biological responses known from river regulation.

Condor, A.L. and N. A. Binns. 1986, Reservoir impact analysis using habitat units for trout streams. Proc. 21 st. Ann. Meet. Colo. - Wyo. Chapt. Am. Fish. Soc: 57 - 63. Technique to evaluate fishery potential of proposed reservoirs using "Habitat Quality Index" (HQI) and "Reservoir Quality Index" (RQI) developed by Wyoming Game and Fish Dept. The output in "Habitat Units" (HU) directly predicts biomass (ex. one HU = one pound per acre fish biomass).

Melton, B.L. and D. Rosgen. 1986. Channel classification -- a method to select stream improvement structures. Ibid. 69 - 72. Classification of river channels into three main types (A,B,C) in relation to stability. The type C channel characteristics of flood plains is unstable. Thus, habitat model predictions made of present channel morphology in type C channels can be expected to be worthless in the future when the channel undergoes modification.

Milner, N.J., R.J. Hemsworth, and B.E. Jones. 1985. Habitat evaluation as a fisheries management tool. Jour. Fish Biol. 27 (supplement A): 85 - 108. This study verifies a point made in my critique -- that intensive study, monitoring, and fine - tuning of a site - specific river habitat predictive model can have predictive success, but when applied to another river, the predictive accuracy disintegrates.

Parsons, B.G. and W.A. Hubert. 1986. Probability curves for kokanee spawning in two tributaries of Flaming Gorge Reservoir. Proc. 21st Ann. Meet. Colo. - Wyo. Am. Fish. Soc: 24 - 33. Comparing actual use of depth, velocity, and substrate by spawning koknee salmon in two tributary streams and constructing HSI curves for each stream, showed the curves .. differed between the streams and both sets of curves differed from the FWS IFIM suitability index curves for kokanee salmon.

Williams, J.E., et al. (7 authors). 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Jour. Ariz. - Nev. Acad. Sci.

20(1): 62 p.
A general overview of rare fishes of the Southwest.

U.S.F.W.S. 1986. Endangered Species Tech. Bull. 11 (6): 9. The first record of finding a young squawfish (six inches in length) in the Salt River from the stocking of two - three inch squawfish in Sept. 1985. It is also mentioned the 12 of the more than 300 adult squawfish stocked in the Verde River last year were recaptured this year.

U.S.F.W.S., W.E.L.U.T. Memo on "Update of Legal and Institutional Information on Instream and Wetland Uses of Water" (dated June 30. 1986). Discussion of the "Instream Flow Information System" a computer data base with two data sets: "STRATEGIES" and "IFIS STUDIES", both sets are maintained on C.S.U. "Gold machine". The STRATEGIES data set contains 1,725 records of court cases, statutes, scholarly articles, policy, etc. The IFIS STUDIES data set is currently being developed and contains 96 records of instream flow studies.

GILA RIVER ADJUDICATION
Bimonthly Progress Report

Consultant: Robert J. Behnke

Time Period: September 1 - October 31, 1986

Activities and Accomplishments: During this period I prepared a brief opinion regarding potential fisheries impacts from six proposed impoundments in Salt River drainage at request of Joe Berquist, PRC Engineering.

I contacted Mr. Joe Urbani (Interfluve, Bozeman, MT) in regards to a fishery survey on the North Fork of the White River for proposed Miner Flat Dam, conducted in June, 1986. This survey documented the fish species found in the North Fork at the proposed dam site area with special emphasis on determining the possible occurrence of the threatened loach minnow, Tiaroga cobitis (which was found in June, 1985, just downstream from confluence of N. Fk. and East Fork). No loach minnows were found. This survey found three native species: speckled dace, desert sucker and Sonoran sucker, and three non-native species: brown trout, rainbow trout and northern pike.

As mentioned in last bimonthly report, I had visited with Pacific Gas and Electric (PGE) biologists in California to discuss instream flow problems they had encountered. I received a copy of a PGE instream flow analysis report prepared for application of amendment of license to the FERC. This document is an example how PGE avoided a costly and unneccessary IFIM (Instream Flow Incremental Methodology) study by bringing in outside expertise (D.W. Reiser of Bechtel) to verify that PGE's previous instream flow analysis was adequate for the purpose of the application and an IFIM study would serve no useful purpose (copy of Mr. Reiser's letter in appendix of report is enclosed for SRP information). Actually, the PGE instream flow methodology has some advantages over the FWS' IFIM because biological parameters such as food producing areas are included.

A symposium featuring eight papers on the Index of Biotic Integrity (IBI) was held at the annual meeting of the American Fisheries Society in Providence, R.I., in September. I received abstracts of the eight papers and discussed the symposium with some of the participants. The main conclusion to be drawn from the symposium is that the IBI must be adjusted and modified in accordance with the unique fish assemblages for any particular geographical region if it is to be a useful tool for biological monitoring (see Leonard and Orth 1986, and Miller et al. 1986: annotated bibliography). I obtained copies of publication (Karr et al. 1986) distributed at IBI symposium and sent one to Byron Lewis for forwarding to Bill Warskow.

In relation to how habitat suitability index (HSI) curves for IFIM might be developed in situations where little or no detailed, quantified data exists on the fish species (such as in the Salt River drainage), I obtained a copy of a workshop proceedings that developed " consensus" curves for fishes of the Platte River, Nebraska, where optimal flows are targeted for birds (cranes) (see Fannin and Nelson 1986). "Consensus" HSI curves are developed by consensus of expert opinions and not field study. This method is explained in detail in the latest FWS publication in IFIM (Bovee 1986).

An announcement for a new journal, "Regulated rivers research and

management", is enclosed for forwarding to Bill Warskow.
In September, I gave a deposition in a case concerning a New Mexico Indian Pueblo's litgation over water quality, in which I had opportunity to pracice what I learned at last year's legal seminar.

ANNOTATED BIBLIOGRAPHY
(LITERATURE ABSTRATED SEPT.-OCT. 1986)

Bovee, K. D. 1986. Development and evaluation of habitat suitability criteria for use in the instream flow incremental methodology. U.S.F.W.S. Biol. Rep. 86(7): 235p. This is the latest official pronoucement on the "rules" of IFIM. It includes discussion on study planning and design, criteria development, field methods, statistical methods, and methods for evaluation.

Bowlby, J.N. and J. C. Roff. 1986. Trout biomass and habitat relationships in Southern Ontario streams . Trans. Am. Fish. Soc. 115 (4) : 503 - 514. An attempt was made to correlate trout habitat variables to trout biomass, using the Binn's Wyoming method. Virtually no correlation was found, which again demonstrates that "site - specific" methods developed for one geographic region cannot be expected to work in another region.

Conder, A.L. and T.C. Annear. 1986 (in press). A test of weighted usable area estimates derived from 2 PHABSIM model for instream flow studies on trout streams. Accepted for publication in North Am J. Fish Mgt. Another attempt to relate weighted usable area (WUA) of IFIM to fish biomass. As with previous studies, no significant correlation between WUA and trout biomass was found.

Elliot, S.T. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Trans. Am. Fish Soc. 115(3): 392-400. After large debris was removed from a stream, the population of Dolly Varden trout suffered a dramatic decline although there was no change in flow or water quality.

Fannin, T.C. and P. Nelson. 1986. Habitat suitability index curves for channel catfish, carp, sand shiner, plains killifish, and flathead chub, developed by consensus discussion for use with the instream flow incremental methodology on the central Platte River. USFWS, Nat. Ecol. Cent., Fort Collins, CO:120 p. A workshop with 14 experts developed "consensus" HSI curves for fishes of Platte R., Nebraska.

Goertler, C.M., T. M. Wesche, and W.A. Hubert. 1985. Development of brown trout habitat suitability index models. Report submitted to USFWS. The authors of this report applied the FWS' HSI curves to Wyoming trout streams to test the predictive accuracy of HSI values for brown trout (the most sophisticated model yet developed for any fish species) by comparing HSI values with actual trout biomass for several streams. No correlation was found.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters. A method and its rationale. Ill. Nat. Hist. Surv. Spec. Pub. 5 : 28p.
A copy of this publication was sent last month for Bill Warskow.

Layher, W.G. and O.E. Maughan. 1985. Spotted bass habitat evaluation using an unweighted mean to determine HSI values. Pros. Okla. Acad. Sci. 65 : 11-17. HSI curves developed for spotted basss were tested in

an Oklahoma river. Individual curves for specific habitat variables showed good correlation between HSI values and fish population, but when all curves aggragated into overall HSI value, there was little correlation -- the individual variables tended to cancel each other.

Leonard, P.M. and D.J. Orth. 1986. Application and testing of an index of biotic integrity in small, coolwater streams. Trans. Am. Fish. Soc. 115(3) : 401-414. An example of how IBI must be modified in relation to fish species composition of particular geographical area.

May, B. and J. Fraley. 1986. Quantification of Hungry Horse Reservoir water levels needed to maintain or enhance reservoir fisheries. Ann. Rep. Mont. Dept. Fish and Wildlife to Bonneville Power Adm: 191p. Includes comprehesive considerations for regulation of water levels in reservoir to enhance production of target fish species.

Miller, D.L., R.A. Daniels, D.B. Halliwell. 1986 (in press). Development of the index of biotic integrity for Atlantic slope drainages of the northeastern United States. MS prepared for publication. Details the modifications necessary to improve efficacy of IBI as monitoring tool in relation to local fish faunas.

Nehring, R.B. 1986. Stream fisheries investigations, Fed. Aid Study 7-51. Colo. Div. wildlife : 123p. Includes "flow investigations" section comparing flows to trout population abundance using IFIM.

U.S. Army Corps of Engineers. 1982. A guide to the George Palmiter river restoration techniques. Contrib. Rep. 82 - CR1 : 55p. This interesting publication concerns alternative, natural methods to reduce flooding and erosion by stream channel and bank maintenance.

U.S.F.W.S. Instream Flow Chronicle, vol. 3 no. 3 (Oct. 86) This issue discusses the FERC decision to utilize a "Cluster Impact Assessment Proceedure" to assess cumulative impacts from multiple hydroelectric dams in a drainage. The FERC decision to assess cumulative impacts was forced by legal considerations, and is likely to set a trend for future environmental assessments where several regulating dams occur in a drainage.

GILA RIVER ADJUDICATION
Bimonthly Progress Report - Part B

Consultant: Robert J. Behnke
Time Period: November 1 - December 31, 1986

Highlights

Further Comments On Instream Flow Methodologies

Part A of this bimonthly report was sent last month in response to a letter from Mikel Moore and an article in vol. 22, no. 5 of the Water Resources Bulletin. As further elaboration on the bulletin article, which discussed how the FWS' Instream Flow Incremental Methodology was used to resolve a conflict over federal reserves water rights in the Red River, New Mexico, I would re-emphasize that the conflict resolution in this case came about not because of the predictive accuracy of IFIM, but because of the illusion of technique. The model was demonstrably wrong. This is an example where data was substituted for knowledge and precise quantification and objectivity were mistaken for predictive accuracy. Despite all of this, the case was settled out of court and the author praised IFIM as the agent for successful resolution of the conflict. This is a correct appraisal, but for the wrong reasons. It was not the predictive accuracy of IFIM that convinced the negotiators to settle the matter, but the illusion of technique aspect of IFIM that did the job. IFIM printouts could precisely show changes in WUA (habitat quality experessed as Weighted Useable Area) on a daily, weekly or monthly basis for any hypothetical change in flow -- thus, apparantly answering the question of how much change in the fish population occurs with any particular flow. Evidently, no one seriously challenged the assumption that WUA is directly related to abundance and/or biomass of the fish population. In recent times this assumption between WUA and fish population has been challenged and found wanting. FWS personnel now admit that WUA can not be directly associated with fish biomass.

The recent loss of faith in the predictive accuracy of IFIM was apparant during a recent fish sampling workshop at Colorado State University. One FWS speaker admitted that predictive accuracy decreases as the model increases in complexity. Another speaker cautioned that the first rule to be understood is that, "models lie".

IFIM is currently prominently involved in conflict resolution for two major controversies: endangered species in the Upper Colorado River, and Two Forks Dam on the South Platte River proposed by the Denver Water Board. It will be instructive to follow the progress of these two situations.

I received a large package of data and an invitation to participate in two workshops designed to obtain a consensus for establishing habitat suitability curves for squawfish, humpback chub and razorback sucker in the Upper Colorado River. The participants include representatives of the FWS, state agencies and water development interests. The first workshop is scheduled for Jan. 5 - 9, in Salt Lake City.

Two Forks Dam would flood several miles of Colorado's most famous trout stream -- the South Platte River in Cheeseman Canyon. The FWS recently declared this fishery as class 1 (a unique environment that cannot be mitigated). The Denver Water Board had IFIM studies performed and; ironically, are using IFIM to claim that a lost stream fishery can indeed be mitigated by a trade of "WUA's". That is, the Water Board is using FWS' previous claims for the utility of IFIM as a tool for mitigation and conflict resolution by summing all WUA values for river section proposed for innundation and proposing that purchase of public access to presently private sections of another river with a similar amount of WUA's would be full mitigation. The FWS now claims (correctly) that WUA's are not equal between different rivers. Also they claim the Water Board's IFIM study failed to adequately perform a "time series" evaluation and a "macrohabitat" assessment; thereby, greatly underestimating the true quality of the fishery. The Water Board claims that, in any event, the present quality of the fishery is due to river regulation by Chesseman Dam and is an artificial situation. Some of my present and past graduate students are involved in IFIM analysis for both sides of the controversy. It will be interesting and perhaps "predictive" to see how the conflict will be resolved.

IFIM and Verde River

The Quarterly Activities Report of the FWS National Ecology Center (formerly Western Energy and Land Use Team = WELUT) for July - Sept., mentions that assistance was provided to FWS' Phoenix endangered species office for, "reviewing options for hydrograph synthesis on the Verde River". I met with Paul Barrett, FWS, Ecological Services Office, Phoenix, who has been performing the IFIM study of the Verde River (Mr. Barrett was visiting C.S.U. to discuss the possibility of enterring graduate school to work on Ph.D. degree). Mr. Barrett told me that the section of the Verde that is of major concern, is the area above Cottonwood, where a sharp transition occurs. Below this area, the fish fauna is dominated by non-native species and above, by native fishes, including the federally threatened spike dace, *Meda fulgida*. I revealed my association with Salt River Project and the potential for conflicts of interest but Mr. Barrett agreed that a cooperative and concilliatory approach would be preferable to resolve any future conflicts that may arise. He stated he would be willing to meet with SRP personnel and discuss the status of his study. In relation to Mr. Moore's suggestion for an IFIM information meeting, if such a meeting were to be held in Phoenix, Mr. Barrett should be invited. His FWS, Phoenix, phone number is 261 - 4720

ANNOTATED BIBLIOGRAPHY
Literature Abstracted Nov. - Dec., 1986

Berkman, H.E., C.F. Rabeni, and T.P. Boyle, 1986. Biomonitors of stream quality in agricultural areas: fish versus invertebrates. Environmental management 10 (3): 413-419. Compared invertebrate diversity indices and index of biotic integrity (IBI, using fishes) for efficacy as monitoring tools to detect water quality changes. Concluded that invertebrate data are preferable because of fish mobility.

Cummings, T.R. 1986. Effects of brook trout competition on the threatened greenback cutthroat trout in Hidden Valley Creek, Colorado. M.S. thesis, Colo. St. Univ. This study provides some insight into how a non-native species displaces or eliminates a rare native species. In this case, the young brook trout gain an advantage over the native cutthroat trout by monopolizing the best habitat positions. The "bottom line" conclusion is that certain native - non - native fish combinations cannot coexist (such as spike dace and loach minnow with smallmouth bass in Salt River system).

Davies, B.R. and K.F. Walker. 1986. The ecology of river systems. Monogr. Biologicae vol. 60. This book includes chapters on: The Colorado River system; Reservoirs of the Colorado River system; Fish of the Colorado River system; and, Lotic zoobenthos of the Colorado River system.

Petts, G.E. 1985. Impounded rivers. John Wiley and Sons. This book provides a good overview on impacts of dams and river regulation in relation to aquatic biology, hydrology, water quality, channel morphology, invertebrates, fishes, and riparian vegetation. The emphasis is on a synthesis of interdisciplinary research.

Kennedy, G.J.A and C.D. Strange, 1986. The effects of intra- and inter-specific competition on the distribution of stocked juvenile Atlantic salmon, <u>Salmo salar</u>, in relation to depth and gradient in an upland trout, <u>Salmo trutta</u>, stream. Jour. Fish Biol. 29(2): 199 - 214. The habitat "preference" (as would be developed for habitat suitability curves for IFIM) for depth, velocity and cover, for juvenile salmon greatly changed after a competing trout species was removed. That is, the true habitat preference of young salmon, could not be determined when they coexisted with an interacting species.

Smith, J.J. and H.W. Li. 1985. Energetic factors influencing foraging tactics of juvenile steelhead trout, <u>Salmo gairdneri</u>. Pages 173 -180, In L.G. Noakes et al. (eds). Predators and prey in fishes. N. Junk Publ. This paper demonstrates the the "preferred" velocity for young steelhead trout depends on how hungry the fish are. Starved fish will occur in higher velocity to obtain food than fed fish.

USFWS Endangered Species Technical Bulletin 11 (8-9) (Aug. - Sept.

1986). This issue reports on the final rulemaking to formally add the spike dace, Meda fulgida (of Upper Verde R.), to the federal list of endangered and threatened species (as a threatened species); however, the designation of "critical habitat" was postponed (until no later than June 18, 1987 -- two years after the species was first proposed for listing). This issue also mentions preliminary discussions between FWS and Arizona G. and F. Dept. to stock squawfish in lower Colorado River for a "trophy sport fishery".

Whittier, T.R. and D.L. Miller. 1986. Stream fish communities revisited: a case of mistaken identity. Am. Naturalist 128(3): 433-437. Another contribution to current controversy over relative significance of stochastic (random chance) vs. deterministic factors as dominant influences structuring fish communities. The significance of this subject in relation to IFIM or any habitat simulation model based on deterministic assumptions, is that stochastic events destroy the predictive accuracy of the model.

PART A. NOV.-DEC. 86 BIMONTHLY REPORT. CRITIQUE: "QUANTIFICATION OF INSTREAM FLOW NEEDS OF A WILD AND SCENIC RIVER", OR, CONFLICT RESOLUTION BY THE WIZARD OF OZ METHODOLOGY.

ROBERT BEHNKE

The letter from Mikel Moore to Mark De Haven concerning the title article published in the Water Resources Bulletin, vol. 22, no. 5, with the suggestion for an informational meeting on instream flow methodologies, prompted me to write this advanced segment of my bimonthly progress report devoted to this topic.

I have some personal familiarity with this particular case because the U.S. Justice Department contacted me in 1980 to be an expert witness on fisheries and stream flow if the Red River case went to trail.

Briefly, the significance of the Red River case was that the lower four miles of the Red River (a tributary to the Rio Grande in New Mexico) and the Rio Grande in the Rio Grande Canyon area were instantly made "wild and scenic" rivers in 1968 when the Wild and Scenic Rivers Act was passed by Congress. Such rivers included in the Act were to have their "free-flowing" condition preserved to maintain: "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic cultural or other similar values". The problem to be resolved in the Red River case was that the law did not specify or provide guidelines for determining minimum flows necessary to meet the objectives of the law (i.e. how much flow could be depleted from a "wild and scenic" river before the law was violated?). Also the State of New Mexico recognized no legal right for instream flow for the values stated in the federal law. The State of New Mexico filed suit to challenge the federal reserve water right implied by the designation of the Red River as a wild and scenic river. A molybdemum mine located on the river, (Molycorp, a subsidiary of Union Oil), which was an industrial user of the river, supplied the bulk of the legal talent to the State.

The Red River's wild and scenic segment is on BLM land, thus the BLM was the federal agency claiming the reserve water right and BLM biologists gave depositions regarding minimum flows and fishery values. The basis for BLM claims for minimum flows was the single transect method (flows that cover a certain percentage, such as 70%, of the stream channel, or wetted perimeter, of a "critical riffle") and the Tennant method (flows expressed as percent of average daily flow).

The plaintiff's attorney exposed the weaknesses of these methodologies by asking for hard evidence that the BLM could demonstrate the predictive accuracies of the basis for their flow claims--how much an increase or decrease in fish populations would occur if flows were above or below the minimum flow requests? The BLM people could not adequately defend the assumptions on which their flow requests were based so the instream flow incremental methodology was used to provide a more defensible basis for flow claims. At this point (summer of 1980) I was contacted by the Justice Department to review the data and the IFIM results and advise them in preparation for trail. Enclosed are copies of two reports I prepared for the Justice Department on the matter.

The PHABSIM model of IFIM used for the Red River had two components--habitat suitability curves for different life history stages for brown trout and rainbow trout, and a hydraulic simulation model (IFG-4) to predict changes in depth and velocity (and changes in habitat suitability) with changes in flow. The model output was in weighted useable area (WUA) for brown trout and rainbow trout that could graphically depict the amount of habitat available at any given flow (see fig. 2 of publication under discussion). The computer printout of WUA on a monthly basis at different flows for each species-- the quantitativeness, the objectivity of the model-- was impressive. I expressed my opinion that the Justice Dept. could intimidate the opposition with this "illusion of technique" (at that time there were no serious challenges or questions being raised on the biological validity of IFIM to accurately associate fish abundance or biomass with WUA). The Justice Dept. had an impressive amount of quantitative evidence on which to base instream flow claims; the opposition had only "hearsay" type of evidence for any attempt to refute the claims. The expert witness for Molycorp was Dr. Robert Pennak (Univ. Colorado), a noted authority on aquatic invertebrates (but not fishes). If the matter came to trail, I should have been able to impress a judge that I knew more about fishes than did Dr. Pennak.

I did point out some obvious flaws with the IFIM analysis which could prove embarassing if brought out at a trail. For example, I noted that for all life history stages and for all flows, the IFIM model showed rainbow trout to have about 25 to 50% more WUA than brown trout. If the model accurately reflected biological reality, then rainbow trout should be 25 to 50% more abundant than brown trout in the studied sections of the Red River. Sampling data showed brown trout were two to three times more abundant than rainbow trout. A large state fish hatchery at the upstream end of the wild and scenic section of the Red River was continually stocking thousands of rainbow trout into the river. At the downstream end of the Red River, near confluence with Rio Grande, rainbow trout were almost nonexistent. If the stocking of rainbow trout ceased, this species would probably become virtually extinct in the Red River. Thus , if the IFIM model was erroneous on its prediction of species dominance, it was obviously wrong. I found flaws in the assumptions on which the model was based which are mentioned in my reports to the Justice Department and treated more fully in my critique of instream flow methodologies prepared for SRP.

I concluded that if the Red River case went to trail, site-specific data would be needed on which to base habitat suitability curves to make the model approximate the biological reality of the Red River and to be sure that the model output showed more WUA for brown trout than rainbow trout.

The case was finally settled out of court and hailed as an example of how the power or IFIM can be used to resolve conflicts. As the title of my present report indicates, I view the resolution as an example of the Wizard of Oz methodology, whereby if something is believed to be so (even if it isn't) then it becomes so for the purpose of conflict resoulution.

I sent copies of my Justice Dept. reports to the USFWS Instream Flow Group. To my knowledge, this was their first awareness of some of the serious flaws in their IFIM model.

For learning more about the workings of IFIM, I would call attention to a publication cited in my last (Sept.-Oct.) bimonthly report: Bovee, K.D. 1986. Development and evaluation of habitat suitability criteria for use in the instream flow incremental methodology. U.S.F.W.S. Biol.

Rep. 86(7): 235p. Copies may be available from : U.S.F.W.S.,National Ecology Center, 2627 Redwing Rd., Fort Collins, CO 80526-2899.

If an instream flow information meeting is planned, I would suggest we have someone present to answer questions on the "nuts and bolts" aspect--time, costs, manpower etc. My own expertise pertains to theory and principles. One of my graduate students, William Miller, has worked for the USFWS doing IFIM work and currently does IFIM work as a private contractor. Someone with "instream" experience, such as Mr. Miller, should be present for any planned meeting to answer questions that I could not adequately handle.

GILA RIVER ADJUDICATION
BIMONTHLY PROGRESS REPORT

Consultant: Robert J. Behnke
Time Period: Jan. 1 - Feb. 28, 1987

The meeting in Denver of Feb. 13, and discussions with other consultants led to looking for ways that the fisheries - aquatic work might be better integrated with other disciplines (striving for a more "holistic" approach). For example, if grazing in a large part of a watershed changes to HRM, and this might lead to dramatic changes in riparian vegetation, erosion and sediment transport rates, stream channel morphology, etc., then major changes in fish habitat, water quality, flow regimes, and, ultimately fish species compostion can be expected to occur. Along this line, I expanded my literature abstraction to include more material relating to riparian vegetation, watershed restoration, habitat improvement, and fish - eating birds (xerox copy enclosed of paper on eagles feeding on fishes in Salt and Verde rivers). Thus, in addition to keeping up to date on instream flow, habitat assessment, and monitoring methodologies, I am establishing an information base to respond to a broader range of aquatic related questions. This is reflected in the enclosed annotated bibliography.

ANNOTATED BIBLIOGRAPHY
Jan. 1 - Feb. 28, 1987

Angermeier, P.L. and J.R. Karr. 1986. Applying an index of biotic integrity based on stream-fish communities: considerations in sampling and implementation. N. Am. J. Fish. Mgt. 6(3) : 418-429. Additional guidelines for refinement of the IBI monitoring method.

Bartholow, J.M. and T.J. Waddle. 1986. Introduction to stream network habitat analysis. U.S.F.W.S. Instream Flow Paper no. 22:242p. The latest in a series of papers on the Instream Flow Incremental Methodology. "Network" analysis relates to methods for basin - wide, cumulative impact analysis.

Bonneville Power Authority (many publications). I had my name put on mailing list for all fisheries and wildlife publications sponsored by BPA. I have received numerous reports on mitigation enhancement , instream flow, and restoration projects in Columbia River basin.

De Graff, D.A. 1986. Habitat use and preferences of juvenile Atlantic salmon in two Newfoundland rivers. Trans. Am. Fish. Soc. 115(5):571-681. Young salmon were found to use two types of habitats: typical riffle areas and backwater areas with vegetation. Points up a basic problem with habitat suitability curves (used in IFIM) because velocity use (or "preference") is not independent of habitat type as it is assumed to be in IFIM model.

Dombeck, M., J. Hammill, and W. Bullen. 1984. Fisheries management and fish dependent birds. Fisheries 9(2): 2-4. A plea for fisheries-aquatic assessment studies to include consideration of fish-eating birds (see citation to Haywood and Ohmart).

Gore, J.A. (ed.) 1985. The restoration of rivers and streams : theories and experience. Ann Arbor Science book : 280p. This book contains chapter by Anderson and Ohmart re. restoration of riparian area in Arizona.

Haywood, D.D. and R.D. Ohmart. 1986. Utilization of benthic-feeding fish by inland breeding bald eagles. The Condor 88:35-42. Data on eagles diet along Salt and Verde rivers, including Fort McDowell site. Two non-native fish species, carp and channel catfish, are most important food. Copy of this paper enclosed.

Mathur, D., W.H. Bason, and C.A. Silver. 1986. Reply to : "In defense of instream flow incremental methodology". Can. J. Fish. Aquat. Sci. 43(5) : 1093-94. Response to Orth and Maughan (cited below) re: debate on merits or lack thereof of IFIM (discussed in my critique report). The authors vigorously attack the statistical and biological assumptions of IFIM, emphasizing their point of view that IFIM is without validity or merit and should not be used for intream flow analysis.

Miller, J. G., J. A. Arway, and R. F. Carline. 1987. Proceedings

of Fifth Trout Stream Habitat Improvement Workshop. Penn. Fish Comm.: 238p. Series of papers on state-of-art for habitat improvement, restoration, assessment and monitoring.

Nnaji, S. and E. J. Hayter. 1985. Methodology for establishing comprehensive instream requirements and predicting flow deficiencies. So. Car. Water Resources Res. Inst. Rep. no. 120.

Orth. D. J. and O. E. Maughan. 1986. In defense of the instream flow incremental methodology. Can. J. Fish. Aquat. Sci. 43(5) : 1092-93.

Restoration and Management Notes. A journal published by Univ. Wisconsin Press, reviewing latest techniques for restoration of disturbed lands, especially wetland and riparian sites. Latest issue is vol. 4 no. 2.

Singh, K. P. and S. Broeren. 1985. Basinwide instream flow needs. Univ. Ill. Water Resources Cent. Res. Rep. 197.

U.S.F.W.S. Endangered Species Bulletin 11 (10,11). This issue states that the loach minnow, _Tiaroga cobitis_, was formally listed as a threatened species (final rule published Oct. 28, 1986). A decision on designation of "ctitical habitat" was postponed until June, 1987 "in order to gather additional data on economic impacts". This fish, in Salt R. drainage, is known only from upper White R. on White River Apache Reservation.

U.S.F.W.S. Instream Flow Chronicle 4(1). Reports latest happenings in the world of IFIM. This issue reports on Alaska's instream flow program.

University of Washington. Abstracts from symposium on "streamside management : reparian, wildlife and forestry interactions" (Feb. 11-13, 1987). This and recent companion symposium emphasizing fisheries-aquatic ecosystems should be published this year.

BIMONTHLY REPORT

March-April, 1987

In addition to the routine literature review and synthesis, the enclosed report, requested by Bill Warskow, reviews the Arizona documents pertaining to selection of an instream flow methodology for Arizona. I point out in the report that the federal and state employees making up the Instream Flow Subteam, had, most likely, already preselected IFIM as the preferred methodology. The rating system used to justify selection of IFIM is without supporting evidence and includes no field tests or comparisons to justify the selection. Several years ago, the Wyoming Game and Fish Department created a "subteam" to investigate methods and methodologies to be used in Wyoming for instream flow claims. The various methods were field tested and compared to their predictive accuracy (association of rankings to actual fish biomass). It was found in Wyoming (as elsewhere) that IFIM is an extremely weak predictor of biological reality. Virtually all knowledgeable practioners of instream flow assessment currently agree that IFIM should not be used for decision making. Why then, should considerable time and money be spent to develop data that has little or no biological relevance?

My suggestion is to substitute biological knowledge of a target species and its environment for meaningless data. If a relevant cause-and-effect relationship is known between flow and an important life history aspect, such as reproduction, then one of the hydraulic simulation models of IFIM could be used to associate depth with any given flow.

The U.S.F.W.S. has, conservatively, invested at least $250,000 for developing data to be used for habitat suitability curves so that IFIM could be used for determining instream flows for Colorado squawfish in the upper Colorado River basin. After two meetings of "experts", no general consensus on the "best" curves could be reached. Simply stated, a wide ranging species such as the squawfish, utilizing a variety of habitats, is highly resistant to oversimplified compartmentalization of its life history into a few "suitability curves" in any way resembling biological reality. A similar situation should be avoided in Arizona. Broad and lasting commitments to any methodology should be resisted.

Otherwise, considerable time and money could be wasted without any benefits to the target species.

I edit English translations of Russian journals and noted a recent emphasis on investigations to determine the best biological monitoring methodologies using various European modifications of invertebrate diversity indices and bacteria types. These papers (2 cited in bibliography) add a broader perspective to the monitoring information base.

ANNOTATED BIBLIOGRAPHY

March-April, 1987

California Trout, Streamkeepers Log. 1987, no. 48.

This newsletter reports on a pertinent controversy concerning the purpose of instream flow: for endangered species (eagles) or trout. When FERC license for PG&E's Britton Dam on the Pit River, California, was under review, the California Department of Fish and Game, the U.S. Forest Service, and trout conservation organizations fought for a minimum flow release to favor the trout fishery in the Pit River. The Endangered Species section of the U.S. Fish and Wildlife Service favored frequent dewatering of the river, as had occurred in the past, to favor feeding of eagles. Evidently, under pressure, the USFWS changed its stance and a 300 cfs instream flow stipulation was adopted.

Fausch, K. D. and L. H. Schrader. 1987. Use of the index of biotic integrity to evaluate the effects of habitat, flow, and water quality on fish communities in three Colorado Front Range rivers. Colo. St. Univ. 53 p.

This report summarizes the results of application of the index of biotic integrity (IBI) as a monitoring tool for Colorado rivers. The need to modify the IBI for regional conditions is clearly demonstrated in relation to the species used and their ecological classification. Due to great fluctuations in flows in western rivers, the IBI scores changed seasonally (lowest at low flows).

Gowan, C. and N. R. Kevern. 1985. An assessment of the impact of irrigation withdrawals on trout habitat in a southern Michigan stream. Papers, Mich. Acad. Sci. Arts, Letters 17(2):149-155.

This paper reports on first attempt to use IFIM methodology in Michigan. The authors naively assumed that WUA is a true surrogate of habitat quality and predictive of fish population change.

Hall, G. E. and M. J. Van Den Avyle (eds.). 1986. Reservoir fisheries management and strategies for the 80's. South. Div. Am. Fish. Soc. 327 p.

Chapters concern reservoir water level management, river regulation, impacts, mitigation and enhancement measures in relation to fisheries and water quality.

Hilborn, R. 1987. Living with uncertainty in resource management. N. Am. J. Fish. Mgt. 7(1):1-5.

This short article is pertinent to current confusion regarding selection of instream flow methodology in Arizona. It emphasizes the uncertainties (stochastic processes) for predictions and how to "expect the unexpected".

McClendon, D. D. and C. F. Rabeni. 1987. Physical and biological variables useful for predicting population characteristics of smallmouth bass and rock bass in an Ozark stream. N. Am. J. Fish. Mgt. 7(1):46-56.

A good review of problems for developing accurate predictions of fish populations from habitat characteristics.

Pshenitsyna, V. N. 1986. Effectiveness of the Woodiwiss Scale as a bioindicator of water quality. Hydrobiol. Jour. 22(4):40-44.

Example of Russian application of a biological monitoring method developed in England as modified for use in the Volga River. Results of various monitoring methods are compared.

Smith, R. A., R. B. Alexander, and M. G. Wolman. 1987. Water-quality trends in the nation's rivers. Science 235:1607-1615.

Data presented from two nationwide sampling networks to discuss trends in water quality during 1974-1981.

U.S. Fish and Wildlife Service. Instream Flow Chronicle 4(1) April, 1987.

Latest news re. IFIM. Mentions release of EPRI report on instream flow methodologies.

U.S.F.W.S. Endangered Species Bull. 1987.

Issue 12(2) mentions that the Haulapi ~~Mtns.~~ vole of NW Arizona has been proposed for listing as an endangered species and that its habitat is threatened by a proposed water development.

Issue 12(3) mentions the Bur. Reclamation's 4-year Arizona bald eagle study and that razorback sucker and bonytail chub were stocked in ponds on the Buenos Aires National Wildlife Refuge, Arizona, and razorback suckers were also stocked on the Imperial Wildlife Refuge, Arizona, as part of recovery effort.

White, R. J., J. D. Wells, and M. E. Peterson. 1983. Effects of urbanization of physical habitat for trout in streams. Montana Water Resources Res. Cent. Completion Rep. 41 p.

This work measured trout abundance and biomass in natural and urbanized streams and recorded habitat data. Attempts to predict biomass by use of the Wyoming (Binns) methodology was unsuccessful. Discussion on modifying habitat classifications and statistical analysis for improved predictive accuracy are pertinent to Arizona instream flow considerations and selection of a methodology because it illustrates that new information and modifications to any model are necessary for each site studied.

Zhdanova, G. A. et al. 1986. Comparative evaluation of water quality in the river sections of Kanev Reservoir. Hydrobiol. Jour. 27(5):59-64.

Another example of current Russian interest in water quality monitoring. Several methods using invertebrates and bacteria were compared.

REVIEW OF INSTREAM FLOW DOCUMENTS

Robert Behnke

April, 1987

The following comments pertain to the establishment of a methodology for instream flow recommendations in Arizona, based on the documents sent by Bill Warskow. I critically reviewed the documents: "Comparison of different methods used to determine instream flow requirements", by Marty Jakle, and "Review of instream flow methodologies and recommendations for their application in Arizona", by the "Biological Subteam".

I found that the members of the Biological Subteam (Mr. Jakle is a member of Subteam) to be highly biased in favor of the IFIM of the U.S. Fish and Wildlife Service. The reports appear to be merely a defense of a predetermined selection favoring IFIM over any other methodology.

In Mr. Jakle's report, the pros and cons of each methodology are listed. The "pros" of IFIM include "defendable" and "biologically sound". Both assumptions are wrong. What might be "defendable" is the quantitative output of IFIM as weighted useable area (WUA), but as explained in my critique and bimonthly reports, WUA lacks predictive association with biologically meaningful parameters such as species biomass. Until this can be demonstrated, all that can be "defended" is a concept (WUA) without demonstrable biological relevance. Without biological relevance, IFIM cannot be "biologically sound".

One of the "cons" or a weakness listed in Mr. Jakle's report for the Modified Tennant Method is that this method "relies heavily on the judgement of the investigator". I would consider the factor of human "judgement" (the flexibility of a model to utilize the human element of knowledge, experience and expertise in contrast to the mere substitution of data for knowledge) to be a "pro" or strong point of a method rather than a "con" or weakness, as I discussed in my May, 1986 Critique report.

It seems apparent from reading the "Review of Instream Flow Methodologies", prepared by the Instream Flow Biological Sub-Team, that the members were already predisposed to favor the IFIM of the U.S. Fish and Wildlife Service and the report is an attempt to justify their preselection of a methodology.

In the review of strengths and weaknesses of IFIM, the Subteam accurately reviewed the weaknesses on p. 13 of their report. They recognized that WUA cannot validly be associated with species biomass and, "this invalidation makes fish population prediction abilities tenuous at best." "If there is no relation between WUA and fish standing crop, then factors other than depth, velocity and substrate must limit populations." They recognized the IFIM assumption of independent selection of habitat variables by fish is invalid. The assumption of stream channel stability not changing through time was also recognized to be invalid. Other statements include: "Owing to the multitude of physical, biological, and environmental interrelationships in aquatic ecosystems, one cannot accurately predict effects of flow alteration on fish standing crops and habitat carrying capacity." The calculation of WUA from habitat suitability curves can be highly erroneous because "habitat preference is not constant."

The predetermined conclusion of the subteam is then stated: "Although inherent problems exist with this methodology (IFIM), it does provide the 'best available information' on the effect of a given flow regime on the fish habitat". Unless placed in the context of predetermined selection of a flow methodology, such a statement is bewildering. It has been admitted that the "best available information" obtained from an IFIM analysis can be expected to be wrong and not predictive. Why such wrong information obtained from IFIM is better (or "less wrong") than that obtained from other methods is not explained.

The "strengths" listed by the subteam to favor IFIM contradict what the team had recognized as weaknesses. I will discuss a few of the "strengths". "Can be used for negotiations since it provides information on the effects of a variety of flow regimes." The use of IFIM for "negotiation" has been touted as a major selling point. The fact that must be recognized is that what is used for negotiation is a display of WUA values which change with flow changes. Until a WUA can be directly associated with a biologically relevant factor such as fish biomass, environmental assessments using WUA's for negotiation is analogous to negotiating with play money in the game of Monopoly. "Biologically sensitive through development of weighted habitat criteria and electivity curves". The team has confused WUA with biological relevance. IFIM is "WUA sensitive" not biologically sensitive. "Provides estimates of the effects of various flow regimes on fish habitat." This statement is true, but it needs qualification to point out that the "estimates" are likely to be highly erroneous.

"IFG4 and HABTAT (components of IFIM) have the potential for predicting species composition changes and fish standing crops as a result of water development projects". Any other methodology or coin flipping also has this "potential" (with similar prospects for correct prediction). "Use of WUA allows for comparisons to be made among streams in assessing the impact of alternative flows". The only valid assessment of impact concerns impact of changes in WUA, not biologically relevant impacts.

The team ranked all methodologies according to their perception of biological sensitivity, adaptability, legal defensibility, and negotiation flexibility -- and IFIM was awarded the highest scores (table 2 of report). I would point out that in reference to "defensibility" and "negotiability", certain "rules of the game" must be defined and accepted by all players. Similar to play money acting as a surrogate for real money in the game of Monopoly, WUA's must be treated as play money -- a make-believe surrogate of some biological reality. If this is agreed upon by all the players in the game of "biological assessment" then IFIM (or any other methodology) is indeed defensible and has good negotiability. It must be recognized, however, that this "game" with WUA's as the unit of currency bears little resemblance to the real biological world.

I would suggest that the Instream Flow Subteam go back to the drawing board and devote more critical thinking and reflective judgement to the matter of selection of methodologies -- at least deciding that no current methodology can be considered as highly predictive and thus should not be the final word for decision-making. For this, the members of the subteam should read the final report: "Instream Flow Methodologies", released by the Electrical Power Research Inst. (EPRI) EA-4819, Sept. 1986: 340 p. A draft of this report was reviewed in my July-August 1985 bimonthly report. I noted an announcement of the EPRI report in the April, 1987 issue of "Instream Flow Chronicle" (compiled by U.S.F.W.S., published by Colo. St. Univ.). The review of the EPRI report states a conclusion that: "...model outputs should not be treated as the principal determining factors for instream flow recommendations." I assume that Salt River Project is a member of EPRI and has received this report. If not, inquire to: Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303.

If my bimonthly reports, critiques, etc. are not regarded as proprietary information, I suggest that copies of my work for SRP (including this report) be supplied to the Instream Flow Subteam.

I noted in the documents sent to me that many pages are devoted to the legal and institutional aspects of the instream flow law in Wyoming, but nothing is mentioned of the activities of the Wyoming Game and Fish Department to investigate methodologies to be used as a basis for instream flow request (which is comparable to the activities of the Arizona Instream Flow Team to assess methodologies for use in Arizona, except that Wyoming biologists performed comparative field tests of the different methods). Papers on the Wyoming tests of instream flow methodologies have been cited in my bimonthly reports. Wyoming biologists found IFIM to be among the most inaccurate of instream flow methodologies in relation to predicting fish biomass. The Arizona Instream Flow Team should become familiar with the Wyoming work.

My comments have been essentially negative and, in fairness, I should offer alternatives to "instream flow methodologies". This would constitute a major report in itself, but I would suggest a few generalities and examples to be kept in mind. In Arizona, the annual hydrograph of most unregulated streams are characterized by extreme "flashiness" -- the maximum daily flow can be expected to exceed the minimum daily flow by 1000 times in an average year and perhaps by 10,000 times every 25 years. Under such an annual natural flow regime, the only feasible way to have any kind of optimal or even minimal instream flow assured is by large impoundments storing peak run-offs to be released later in the year. Thus, in relation to fish, wildlife or riparian vegetation instream flow, some reservoir storage would have to be designated for these purposes.

In regards to priorities, a case by case approach will be necessary with the objectives and target species clearly defined. For example, various objectives might be: maintenance or enhancement of a native fishes assemblage; a particular species of threatened or endangered fish; non-native gamefishes such as rainbow trout, smallmouth bass; cottonwood trees, bald eagles, etc. Then the human element of knowledge would be required to look for the most simple and direct cause-and-effect relationship between flow and the target species that is amenable to quantification. For example, if a population of the threatened loach minnow is found to utilize a riffle area in a stream and when flows drop below a critical level, the riffles are dewatered and the loach minnow population declines, then the critical flow necessary to maintain the riffle habitat must be determined. If a rainbow trout fishery depends on natural spawning, the spawning area should be studied. If the average depth of egg deposition is one foot, the question in need of an answer is: how much flow reduction causes a decrease in depth by one foot in the spawning area (resulting in loss of incubating eggs)? Critical habitat sites for particular species, such as side channels, undercut banks, etc. would need to be studied for each stream and then determine what flows would be too high or too low to maintain habitat quality.

The introduction of human knowledge (judgement) into any method to determine instream flow would increase the "biological sensitivity" of the method (if knowledgeable humans are properly used to develop the knowledge).

GILA RIVER ADJUDICATION
Progress Report

Consultant: Robert J. Behnke

Time Period: May 1 - May 31 (literature review)
June 1 - June 30 (addendum to instream flow critique).

Accomplishments: Pertinent literature was reviewed and abstracted (annotated bibliography attached) and "reinforcement" learning type of examples, clarifications and additional literature citations compiled for addendum to recent "critique of instream flow methodologies. Received Judge Goldfarb's pretrail orders, noting requirements for written reports from expert witnesses. Received "glossary" from ERO and I will send a glossary of instream flow assessment terminology to ERO for additions to consider for revision.

ANNOTATED BIBLIOGRAPHY

Anonymous. 1986. Final rulemaking lists desert pupfish as endangered. Only Arizona critical habitat is Quitobaquito Spring (National Park lands). Endangered Sp. Tech. Bull. 11(4): 5-6.

Fausch, K. D. and L.H. Schrader. 1986. Application of and index of biotic integrity to three Colorado Front Range streams. Prog. Rep., Dept. Fish., Wildlige Biol., C.S.U.

An attempt to modify IBI to local conditions. A symposium on IBI will be held in September at annual meeting of AM. Fish. Soc.

Glova, G.J. 1986. Interaction for food and space between experimental populations of juvenile coho salmon and cutthroat trout in a laboratory stream. Hydrobiologia 132: 155-168.

Another example of "niche shifts" resulting from interacting species, again illustrating the enormous complexities faced by an ecological or habitat model attempting to predict changes in a species abundance. Niche shifting depended on temperature -- an additional complexity.

Harvey M.D., C.C. Watson and S, A, Schumm. 1985. Gully erosion. U. S. Bur. Land Mgt. Tech. Note 366: 181p.

This publication is of particular interest to hydrologists. The innate "drive" of a channel to alter its morphology and gradient, especially when subjected to a change in flow regime emphasizes problems of predicting changes in fish populations based on habitat measured under static conditions at any point in time.

Mishall G.W. (and six other authors). 1985. Developments in stream ecosystem theory. Can. J. Fish. Aquat. Sci. 42 : 1045-1055.

A review and updating of the "River Continuum Concept", a holistic integration of ecological theory and principles to better understand the biological functioning of flowing waters.

Vrijenhoek, R.C., M. E. Douglas, and G.K. Meffe. 1985. Conservation genetics of endangered fish populations in Arizona. Science 229 : 400-402.

Re. Sonoran topminnow, Poeciliopsis occidentalis, and genetic implications of small, isolated popuations.

Willams, J.E. (and six other authors). 1985. Endangered aquatic ecosystems in North American deserts. Jour. Ariz - Nev. Acad. Sci. 20 (1) : 62p.

A gereral review of endangered and threatened fishes of the Southwest and their habitats.

FISHERIES-AQUATIC BIOLOGY BIMONTHLY REPORT
May-June 1987
Robert Behnke

In May I received copy of letter to Herb Dishlip from Bill Warskow regarding critique of the Instream Flow Taskforce and their recommendations, based on my April review of the instream flow documents of this task force. I sent Bill a few comments and corrections and also sent a copy of a Canadian bulletin, "Pitfalls of physical habitat simulation in the instream flow incremental methodology" (cited in bibliography under Shirvell 1986). I did not receive further word on the matter and I assume that the Arizona Department of Water Resources is not insistent on the formal adoption of IFIM or any other methodology as the standard Arizona method. I communicated with biologists of the Canadian Department of Fisheries and Oceans in regards to their experience with IFIM (citations in bibliography include Shirvell, Burt and Mundie, and Mundie and Bell-Irving). It is interesting to note that the problems the Canadians have had with IFIM concern consultants working for water development projects using IFIM to justify flows which the Department of Fisheries and Ocean believe are too low to maintain a fishery. This can be easily done because as flow velocity increases, "habitat suitability" (HSI curves used in IFIM) expressed as weighted usable area (WUA) decreases. When flow volume decreases, velocity decreases, and habitat suitability increases. By selecting an opportune river section to make IFIM analysis, maximum fish habitat values can be had at very low flows (according to IFIM).

I was informed by Charles Ziebell, Arizona Cooperative Fishery Unit (ASU), that the Arizona Department of Game and fish is funding a project on the roundtail chub (*Gila robusta*) in the Verde River (between Perkinsville and confluence with Clear Creek). The study would consist only of documenting movement of chubs and to gain an idea of the angler catch of chubs. The impact of smallmouth bass on the chub population is to be ignored. My impression of such a study is one of a state agency desiring to demonstrate its stewardship obligation to native species without stirring a controversy by implicating a negative impact from a popular non-native gamefish.

In my survey of literature, I noted that vol. 16 no. 3 (1986) of Environmental Law is devoted to a proceedings of a symposium on "salmon law", which includes considerable information on FERC licensing, cumulative impacts and legal ramifications of impacts on fishes from flow regulation. The Water Resources bulletin contained outline of a symposium scheduled in May on the monitoring, modelling and mediating of water quality. I expect that the proceedings of this symposium will be published in a future volume of this journal.

A recent addition to the CSU faculty is Rick Knight who has done considerable research on eagles and eagle feeding. I had some discussions with Rick and reviewed a paper he wrote for publication to become more familiar with eagle biology. Rick showed me a paper (copy enclosed) concerning a study on the eagles associated with the Salt and Verde rivers.

I wrote a paper, "The illusion of technique and fisheries management", for the Proc. Colo.-Wyo. Am. Fish. Soc. which is largely based on what I have previously written in my SRP reports (copy enclosed). I believe I sent a copy of this paper last month to Bill Warskow as evidence demonstrating the severe limitations of any method of habitat modelling or monitoring.

ANNOTATED BIBLIOGRAPHY
Literature reviewed and abstracted, May-June 1987

Burt, D. W. and J. H. Mundie. 1986. Case histories of regulated stream flow and its effects on salmonid populations. Canadian Dept. Fish. and Oceans Tech. Rep. 1477. One of the publications mentioned in bimonthly report concerning Canadian problems with instream flow methodologies and their lack of predictive accuracy.

Duff, D. A. 1987. Implementing a Forest Service fish habitat relationship program through GAWS. Proc. 22nd Ann. Meet. Colo.-Wyo. Chapter Am. Fish. Soc.: 52-55. The "General Aquatic Wildlife System" (GAWS) is a computer based information system developed by the Intermountain region of the U.S. Forest Service. Models are designed to relate fish habitat quality to various impacts such as sediment, flow changes, riparian condition, etc. Program was developed to monitor land-use activities on Forest Service lands.

Fausch, K. D., C. L. Hawkes and M. G. Parsons. 1987 (in press). Models that predict standing crop of stream fish from habitat variables (1950-85). A comprehensive review and synthesis of models (and methodologies) that have been used or proposed to associate fish population biomass to habitat parameters. This report will be published by the U.S. Forest Service.

Fletcher, R. 1987. Helping bald eagles keep a foothold in the Southwest. U.S. Forest Serv. Rocky Mtn. For. and Range Exp. Sta., Forestry Research West, Apr. 1987: 15-20. Discusses study of eagles of Verde-Salt rivers (copy enclosed).

Karr, J. R. 1987. Biological monitoring and environmental assessment: a conceptual framework. Environ. Mgt. 11(2): 249-256. Review of the index of biotic integrity (IBI) and its application to monitoring and assessment work.

Kozel, S. J. and W. A. Hubert. 1987. Development of fish habitat relationship models for the Medicine Bow National Forest, Wyoming Proc. 22nd Ann. Meet. Colo.-Wyo. Chapter Am. Fish. Soc.: 56-62. A project funded by Forest Service to discover significance of various associations between habitat variables (channel type, riparian vegetation, substrate, etc.) and trout biomass.

Mundie, J. H. and R. Bell-Irving. 1986. Predictability of the consequences of the Kemano Hydroelectric proposal for natural salmon populations. Canadian Water Resources Jour. 11(1): 14-25. The Aluminum Co. of Canada proposed a hydroelectric project that would divert 84% of the flow of one salmon river and 62% of another. Their consultants used IFIM to propose new flow regimes to minimize loss of salmon. The Canadian Dept. Fisheries and Oceans did not agree with the predictions made from IFIM.

Platts, W. S. and 12 other authors. 1987. Methods for evaluating riparian habitats with applications to management. U.S. Forest Service, Intermtn. Res. Sta. Gen. Tech. Rep. INT-221. A compendium of information on riparian habitat with methods of assessment.

Schlosser, I. J. 1985. Flow regime, juvenile abundance and the assemblage structure of stream fishes. Ecology 66(5): 1484-90. A study in a small Illinois stream demonstrated dramatic changes in fish species composition in high flow and low flow years in relation to species-specific spawning success under different flow regimes. This illustrates that drastic changes in community structure can occur from completely natural causes. A monitoring program based on community structure (relative species diversity) such as IBI would be misled by interpreting the different indices of different flow years as the result of external forces. Considering the great annual flow variations in Arizona streams, the limitations of a biological monitoring program is obvious.

GILA RIVER ADJUDICATION
Monthy (Bimonthly) Progress Report

Consultant: Robert J. Behnke

Time Period: July 10 - Aug. 31

Accomplishments (Highlights) The enclosed annotated references are divided into three categories: methods and method testing, endangered species, and general.

The "methods" references reveal that the naive, simplistic faith in instream flow models and habitat quantification models ~~has~~ is being shattered. I would point to the citations under "EA Engineering" (attack on statistical bases of models), "Larimore and Garrels" (how fish change habitat preferences from day to night), "Li and Schreck" (how habitat preferences change in species depending if they are allopatric (~~by ther~~ no other species) or sympatric (coexisting with other species), "Loar" ~~and~~ (similar to Li and Schreck but with different species and limited to instream flow models), and "Sheppard and Johnson" (how species changes habitat preference from June to October), as examples.

The "Fausch, Karr, and Yant" reference pertains to a new assessment-monitoring tool using fishes -- the Index of Biotic Integrity, currently being fostered by EPA.

The endangered species references

include a listing of introduction sites (in Salt R. drainage) of the endangered Gila topminnow (copies of tables and map included for Bill Warskow).

~~The~~ ~~so~~ "Propst, Marsh, and Minckley" reference ~~includes~~ contains a correction to my report of July 10 (this paper ~~report~~ was received within days after completion of my report). The loach minnow, *Tiaroga cobitis*, was found in White River and E. Fk. White R. on Fort Apache Indian Reservation. The loach minnow was considered extinct in Salt R. drainage until this find. My personal communicant for my July 10 report mistakenly told me it was the spikedace, *Meda fulgida*, that had just been found in the White River.

Pertinent sections from the Federal Register containing definitions of "nonessential experimental" populations and proposals to introduce squawfish and woundfin into Salt R. drainage have been previously sent to Bill Warskow.

~~Most of~~ Only 80 of the "experimental" squawfish ~~were alive~~ being raised at the Dexter, N.M. hatchery to be stocked in Arizona were alive on June 18 (of 85,000 in 1984), ~~thus stocking of~~ ~~no~~

REFERENCES ABSTRACTED ~~AND~~ CONCERNING METHODS AND TESTING OF METHODS

Annear, T.C. and A.L. Conder. 1984. Relative bias of several instream flow methods. N. Am. J. Fish Mgt. 4(4): 531-539. Several methods were compared to predict fishery flows in several Wyoming rivers. The comparisons demonstrated which methods most consistently ~~are~~ disagreed with model values (USFWS' IFIM among "worst").

Armour, C.L., R.J. Fisher, and J.W. Terrell, 1984. Comparison of the use of habitat evaluation proceedures (HEP) and the instream flow incremental methodology (IFIM) in aquatic analysis. U.S. Fish and Wildlife Serv. FWS/OBS-84/11: ~~82/10~~ 30 p. After many years of feuding, the HEP and IFIM (formerly IFG) groups of FWS have combined their efforts in attempt to complement each other (HEP models do not include flow parameters), but new emphasis admits ~~is~~ that simplistic "canned" programs cannot be universally applied in all situations. FWS disclaimer points out that site-specific data will be necessary to modify their models for each local situation. All species "habitat suitability" models now published by USFWS contain both HEP and IFIM models.

EA Engineering, Science and Technology Inc. (no authors listed). 1985. Instream flow methodologies, research project 2194-2, draft report. Prepared

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for Electric Power Res. Inst., Palo Alto, CA. This massive document critiques many instream flow models, especially the USFWS IFIM model. Many problems with the models are delineated, especially the statistical basis on which suitability curves are derived.

Fausch, K.D., J.R. Karr, and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Am. Fish. Soc. 113(1): 39-55. The Index of Biotic Integrity (IBI) was developed to assess and monitor water quality by use of fishes -- no. of species, proportion of omnivores, insectivores, predators, and certain indicator species to derive a metric. The IBI is currently a "hot item" with EPA. One of my students is working on EPA-IBI project in Corvallis, OR, and I am currently supervising another graduate student testing and fine-tuning the IBI for Colorado streams.

Hamilton, K. and E.P. Bergersen. 1984. Methods to estimate aquatic habitat variables. Prepared by Colo. Coop. Fish. Res. Unit for Bur. Recl. Engin. and Res. Cent., Denver. This manual is more than a simplistic review of aquatic sampling methods; it contains such gems of wisdom as: "methodology is the last refuge of the sterile mind" and

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"The probability of failure increases as the investigator's thinking becomes method rather than problem oriented".

Helm, W.T. 1983. Defining stream fish microhabitat requirements for water planning. Utah St. Univ. Cent. for Water Resources Res. Proj. B-177-UT.

Howard, C.D.D. (ed.) 1984. Instream flow workshop: interpretations of physical habitat analysis. Charles Howard and Asc. for Prov. Brit. Col. Ministry of Environ. This interesting document was sent to me by Mark DeHaven. It is one that 'slipped through the crack' of my network to obtain such literature. This is a good synthesis ~~of~~ and ~~state-of-the-art~~ critique of techniques ~~to~~ To relate ~~determine~~ ~~flushing~~ flows ~~flows~~ to habitat criteria ~~(typically, the flow required to clean fi the substrate in fish spawning sites of fine sediment)~~. Includes much unpublished and personal communication type information.

Larimore, R.W. and D.D. Garrels. 1985. Assessing habitats ~~by~~ used by warmwater stream fishes. Fisheries 10(2): 10-16. Demonstrates how habitat suitability curves differ according to sampling technique and how fish change "preferred habitat" from day to night -- that is, why simple, predetermined suitability curves for habitat variables (such as used in FWS' HEP and IFIM models) do not

accurately represent biological reality.

Leathe, S.A. and M.D. Enk. 1985. Cumulative effects of micro-hydro development on the fisheries of the Swan River drainage, Montana. Prepared for U.S. Dept. Energy, Bonneville Power Auth: 114 p. Development of methods to evaluate impacts from dewatering and sedimentation.

Li, H.W. and C.B. Schreck. 1984. Formulation and validating models of habitat quality for cutthroat trout and coho salmon for Oregon's coastal streams. Ore. Coop. Fish. Res. Unit report to U.S.F.W.S., West. ~~Eng.~~ Energy and Land Use Team: 69 p. Demonstrates changes in "habitat suitability" curves due to niche shifts when comparing a fish species ~~alone~~ with no other fishes (allopatric) in habitat ~~with~~ and same species coexisting with another species (sympatric). Another example documenting inadequacy of USFWS suitability curves used in HEP and IFIM models.

Loar, J.M. (ed.) 1984. Application of habitat evaluation models in southern Applachian trout streams. Oak Ridge Nat. Lab., prepared for U.S. Dept. Energy: 310 p. Another detailed documentation of limitations of "canned" models to accurately ~~predict~~ associate habitat parameters with fish abundance and biomass. Also demonstrates shifts in ~~so~~ "habitat suitability" when a species occurs alone and when it coexists with other species. A good critique of problems inherent in USFWS' IFIM models.

~~Mag~~ Mangum, F. A. 1984. The BCI (Biotic Conditioning Index), its development and use in evaluating aquatic ecosystems. Proc. 19th Ann. Meet. Colo.-Wyo. Chapt. Am. Fish. Soc.: 45-50. Describes a modified invertebrate diversity index for assessing and monitoring water quality, used by U.S. Forest Service Intermountain Region.

McConnell, W. J., E. P. Bergensen, and K. L. Williamson. 1984. Habitat suitability index models: a low level effort system for planned coolwater and coldwater reservoirs (revised). U.S. F.W.S. FWS/OBS-82/10: 62 p.

Orth, D. J., R. N. Jones, and O. E. Maugha. 1982. Considerations in the development of curves for habitat suitability criteria. Pages 124-133 in Proc. Symp. on ~~aquatic~~ aquisition and utilization of aquatic habitat information. West. Div. Am. Fish. Soc.

Orth, D. J. and O. E. Maughan. 1982. Evaluation of the incremental methodology for recommending instream flows for fishes. Trans. Am. Fish. Soc. 111(4): 413-435. This, and above citation, essentially discuss why USFWS' IFIM models do not work very well.

Reiser, D. W., M. P. Ramsey, and T. R. Lambert. 1985. Review of flushing flow requirements in regulated streams. Bechtel Group Inc. Contract no. Z19-5-120-84, prepared for Pac. Gas and Electric Co. A good review of 'state-of-art' methods used to determine flushing flows (typically the flow required to clean fish spawning substrates of sediment), and why optimum flushing flows (expressed as % of average daily flow) will change from one river to the next.

Sheppard, J. D. and J. H. Johnson. 1985. Probability of use for depth, velocity, and substrate by subyearling coho salmon and steelhead in Lake Ontario tributary streams. N. Am. J. Fish Mgt. 5(2B): 277-282. Demonstrates significant differences in "preferences" for these environmental components between fishes sampled in June and October. Also, both the June and October "use" curves differ from the curves of the USFWS' IFIM models for these species.

Shirvell, C. S. and R. G. Dungey. 1983. Microhabitats chosen by brown trout for feeding and spawning in rivers. Trans. Am. Fish. Soc. 112(3): 355-367.

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Terrell, J. W. (ed.). 1984. Proceedings of a workshop on fish habitat suitability index models. U. S. F. W. S., West. Energy and Land Use Team Biol. Rep. 85(6):393 p. Some case histories documenting problems with USFWS habitat suitability models -- the lack of agreement between what found in nature and what models predict. Essentially, admittance by USFWS people that they recognize that serious problems exist with their models.

REFERENCES CONCERNING ENDANGERED SPECIES

Brooks, J. E. 1984(?). Factors affecting the success of Gila topminnow (Poeciliopsis occidentalis) introductions on four Arizona National Forests. Prepared for U. S. F. W. S. Office of Endangered Species, Albuquerque: 43 p. Documents 64 sites stocked with Gila topminnow in 1982 and 24 sites stocked in 1983. It is not stated if these introductions were made under the 1982 End. Sp. Act ammendment for "non-essential, experimental populations" only that they were made under a memorandum of → ~~(not protected by ESA)~~, ~~but~~ Because the introduction sites are tiny seeps, cattle tanks, etc. I do not envision any problem with adjudication process even if sites are federally protected. Tables and maps of sites will be enclosed for Bill Warskow for information storage.

→ understanding between USFWS, USFS, and Ariz. Game and Fish Dept.

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Propst, D. L., P. C. Marsh, and W. L. Minckley. 1985 (July 5). Arizona survey for spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis): Fort Apache and San Carlos Apache Indian reservations and Eagle Creek, 1985. Prepared for USFWS Office of End. Sp., Albuquerque: 8p.

This report was received ~~within~~ a few days after completion of my report (July 10) "Information base concerning Salt River fishes". In my report I stated that the loach minnow was presently not known in Salt River drainage. ~~This~~ I also gave a recent personal communication that spikedace had just been found in White R. The report by Propst et al. corrects ~~the~~ my report of July 10. It was the loach minnow, not spikedace, that was found in the East Fork of the White River and in a short reach of the main stem White River just downstream from confluence of North and East forks. Thus, the loach minnow is now documented in Salt R. drainage (on Fort Apache Reservation) and I expect USFWS will propose to include the sites where species was found as "critical habitat" as ~~in~~ ammendment to, the proposed listing of loach minnow as a threatened species.

I obtained copies of pertinent pages of Federal Register, vol. 49, no. 70 with explanation of "nonessential experimental populations" and proposal to stock squawfish and woundfin into Gila R. basin of

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Arizona. Vol. 49 (96), contains proposed listing of desert pupfish (Cyprinodon macularius) as an endangered species. The only 'critical habitat' proposed for Arizona is Quitobaquito Spring, Organ Pipe Cactus National Monument. Vol. 50 (117) contains proposals for listing of spikedace and loach minnow as threatened species. Critical habitat proposed for spikedace includes the lower mile of Sycamore Creek and, continuously, the Verde River upstream to Sullivan Lake. ~~No critical habitat was proposed~~ The loach minnow was unknown in Salt River drainage at time of proposal so no critical habitat was proposed. As discussed above, the recent finding of loach minnow in E. Fk. White River and in White River will probably result in these sites being proposed as critical habitat. The pertinent information from these documents has been previously copied and sent to Bill Warskow for information storage.

~~I~~ noted in the "Endangered Species Technical Bull", 1985 vol. 10 no. 6, that the Little Colorado River spinedace, Lepidomeda vittata, has been proposed for listing as a threatened species. This species is found only in Little Colorado drainage. Critical habitat proposed includes 44 miles of E. Clear Creek, Chevelon Creek and Nutrioso Creek (proposal in May 22 issue of Fed. Reg.).

A note in End. Sp. Tech. Bull. 10 (7) makes

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it doubtful that the "nonessential experimental" squawfish will be stocked this year into Salt and Verde rivers as planned. In 1984, 85,000 baby squawfish were stocked into a pond at the Dexter, N.M., fish hatchery to rear ~~for~~ as "~~ex~~ nonessential experimental" squawfish for the Arizona introductions. This spring only 400 were left and only 80 by June 18. Canibalism ~~was~~ is blamed for their demise. ~~or they are~~

GENERAL REFERENCES

Gislason, J.C. 1985. Aquatic insect abundance in a regulated stream under fluctuating and stable diel flow patterns. N. Am. J. Fish Mgt. 5(1): 39-46. How different insect groups respond to fluctuating flows and dewatering.

Grabowski, S.J., S.D. Hiebert, and D.M. Lieberman. 1984. Potential for introductions of three species of nonnative fishes into central Arizona via the Central Arizona Project - a literature review and analysis. U.S. Bur. Recl. Eng. and Res. Cent. REC-ERC-84-7: 124p. Considers the possibility of transport of striped bass and blue tilapia from Lake Havasu and of white bass from Lake Pleasant to Granite Reef diversion and into Verde and Salt rivers and impoundments. Written ~~as an~~ similar to an environmental assessment, in regards to a

potential impacts on present fisheries, bald ~~eagles~~ eagles, etc.

BIMONTHLY REPORT, FISHERIES-AQUATIC BIOLOGY
July - August, 1987

I received copy of memo from Diane Ballode to Mikel Moore on stream flow records. These graphs essentially summarize the point I made in my report on Fort McDowell Verde River fishery (Feb. 1986, and other reports) that the enormous and unpredictable variations in Arizona stream flows greatly limit meaningful controls or influences for fisheries without large volume storage reservoirs for regulated flows.

A new journal, Regulated Rivers: Research and Management has appeared (vol. 1 no. 1 and 2 were read). An article by Orth from this journal is cited in the annotated bibliography. Dr. Orth has been funded by IFIM since he was a graduate student and has had more practical field experience with IFIM than any other person. Orth's article essentially summarizes many of the "limiting factors" which makes IFIM a poor predictor of fish biomass that I discussed in my critique report. This paper might be called to the attention of the Arizona instream flow subteam, especially pointing out one of Orth's conclusions that the application of all avialable models and knowledge should be encouraged in the assessment process (i.e. IFIM should not be designated as the sole or preferred methodology).

Enclosure 1 reveals a more rational approach by the IFIM group towards promoting their product. This new, "soft sell" approach was also apparent at meeting of Western Division American Fisheries Society meeting, Salt Lake, July 15-17, which I attended. The great success stories and negotiability advantages of IFIM formerly touted were downplayed at instream flow sessions, and discussions focused on better ways to make assessments.

I received a call from consulting firm in early July regarding SRP project and screening irrigation canals to block all fish eggs and larvae. I told the person that I doubted any technology could guarantee 100% success but that I would look into the matter. At the West. A.F.S. meeting I talked to representative of Aquadyne and picked up enclosure 2 on fish screens. The Aquadyne person told me their fish screens will completely block fish eggs and larvae. This literature may be passed on to appropriate SRP personnel.

R. Behnke

ANNOTATED BIBLIOGRAPHY
July - August 1987

Baltz, D.M., B. Vondracek, L.R. Brown, and P.B. Moyle. 1987. Influence of temperature on microhabitat choice by fishes in a California stream. Trans. Am. Fish. Soc. 116 : 12-20.

When the three variables typically used with IFIM (depth, velocity and substrate) were used to predict fish species association with these habitat variables, the predictive accuracy was low (0-20%), by adding additional variables such as water temperature and cover, accuracy increased to 52-77%.

Johnson, J.E. 1987. Protected fishes of the United States and Canada. Am. Fish. Soc. Spec. Publ. contains color photos of some of Arizona's rare fishes -- Gila topminnow, desert pupfish, loach minnow, spikedace, Gila chub, Little Colorado spinedace, and Gila trout.

Karr, J. R., P.R. Yant, K.D. Fausch, and I.J. Schlosser. 1987. Spatial and temporal variability of the index of biotic integrity in three midwestern streams. Trans. Am. Fish. Soc. 116 : 1-11. IBI tested over three year period in Illinois stream. With stable environmental conditions IBI scores were stable through time. Authors claim superior performance of IBI over other diversity methods for stream monitoring.

Lanke, R.P. and W.A. Hubert. 1987. Relations of geomorphology to stream habitat and trout standing stock in small Rocky Mountain streams. Trans. Am. Fish. Soc. 116 : 21-28. Relatively good predictive accuracy was obtained from associating trout population biomass to drainage basin morphology (stream size, order, elevation, gradient, etc.) in comparison to the more commonly used associations between trout populations and instream habitat variables.

Morantz, D.L. R.K. Sweeney,C.S. Shirvell, and D.A. Longand. 1987. Selection of microhabitat in summer by juvenile Atlantic salmon. Can. J. Fish. Aquat. Sci. 44 : 120-129.

Young salmon, depending on size, utilize a similar range of "nose" velocities (water velocity at position of fish) independent of total depth, mean column velocity and substrate. Implications are made for improving IFIM.

Orth, D.J. 1987. Ecological considerations in the development and application of instream flow-habitat models. Regulated Rivers 1(2) : 171-181. Discusses how ecological factors (food, other species, water quality, competition, predation, etc.) influences use of microhabitats by fishes and why these factors should be understood to explain lack of predictive accuracy of IFIM. Conclusion is that all available models and knowledge should be encouraged in the assessment process (i.e. avoid sole reliance on IFIM).

Shirvell, C.S. 1987. Does the IFIM have biological significance: A critique. Instream Flow Chronicle (enclosed). It is of interest that this official promotional publication of IFIM published this unfavorable critique and that the response is characterized by caution and rational discussion rather than a kneejerk defense.

USFWS, National Ecology Center Memoradum on update of legal and institutional affairs related to wetlands and instream flow uses of water (July 10, 1987). Abstracts of current events of this subject matter.

BIMONTHLY REPORT: FISHERIES AQUATIC BIOLOGY
November - December 1987

Robert Behnke

Instream Flow, Habitat Issues

I attended the Desert Fishes Council meeting in Hermosillo, Mexico, in November. Papers were presented on attempts to use IFIM for developing flow recommendation (after which I was invited to present my paper of the Illusion of Technique). Many problems frustrated any definitive conclusions except for a remark by the FWS biologist in charge of the studies that "IFIM is no damn good" and that the habitat suitability curves made for squawfish and other species (cited under Valdez et al. in bibliography) are examples of "cartooning." I mentioned in my critique of instream flow methodologies that as rivers leave stable channels in canyons, enter onto unstable floodplains, the channel morphology can be expected to change from year to year or after each flood event, so that any river channel section quantified for IFIM studies to establish "weighted usable area," should be expected to change in the future. This phenomenon was indeed found in IFIM studies on the Green River. The same river section measured at precisely the same flow, gave very different WUA values from one year to the next because the channel had changed configuration. Because of the obvious empirical problems encountered for the use of IFIM, FWS administrators have decided that IFIM will not be used for decision-making regarding flows for endangered species.

A FWS spokesperson at the meeting blamed most of the problems with inappropriate use or misuse, but admitted it is labor intensive and expensive, and that a flow-habitat relationship measured at one point in time is only one of many factors that influence fish populations (obviously true, but previously not admitted). Major emphasis for "selling" IFIM now appears to be to package it as a negotiating tool (see enclosure on course announcement).

Another aspect explaining lack of predictive accuracy of IFIM discussed in my critique concerned seasonal differences in habitat use. In relation to this, several recent studies were made of fish habitat use during winter (citation in bibliography to Chisholm et al. and to Hillman and Griffith). Squawfish winter studies in the Yampa River have been made during 1985, 1986, and 1987 by C.S.U. graduate student Ed Wick. Mr. Wick began his work with the goal of developing habitat suitability curves for squawfish winter habitat for use with IFIM (the physical habitat simulation component or PHABSIM). It was found that squawfish mainly live in off-channel habitat (backwaters, embayments, side channels) during the winter and that characterizing the river channel for WUA bears no relationship to the habitat actually used by squawfish. It was also found that ice cover markedly affects USGS gaging stations by raising water levels which may give a flow reading up to 50% above actual flow.

Also in November, I participated in a two week stream habitat course sponsored by the U.S. Forest Service, held at C.S.U. The course contained several valuable hydrology and river mechanics presentations.

Endangered Species

The bibliographic citation to the Federal Register re. Gila trout, reveals a location for Gap Creek (the only Arizona population of S. gilae) as in the Cedar Branch Wilderness Area of Prescott National Forest. Note that no "critical habitat" was listed for S. gilae. The Endangered Species Act calls for listing of "critical habitat" at the time of listing, "to the extent prudent." The USFWS has been instructed not to list critical habitat for any new listing (which may bring on legal action). Each species of plant and animal that has been listed as endangered or threatened in recent months in the federal register, has a different explanation why it is "not prudent" to list critical habitat. The Gila trout was on the USDI endangered species list prior to the passing of the 1973 Endangered Species Act and was grandfathered onto the present list without critical habitat being designated. The change in status from endangered to threatened would call for listing of critical habitat at this time -- but it was found "not prudent" to do so. The Gap Creek population is introduced, not native, but Gap Creek would have automatically become "critical habitat" if FWS personnel had not been instructed otherwise because the introduction occurred before the amendment to the Endangered Species Act allowing for introductions of "experimental, nonessential populations" such as the introductions of squawfish and woundfin (Plagopterus) in the Verde and Salt river drainages.

Reviews and updating of current studies on Arizona's endangered and threatened fishes were given at the Desert Fishes meeting. Bonytail chub and razorback suckers raised in ponds on the Buenos Aires National Wildlife Refuge and Arizona State University Research Park exhibits "world record" growth (water in these ponds is from Salt River canals).

ANNOTATED BIBLIOGRAPHY

Chisholm, I.M., W.A. Hubert, and T.A. Wesche. 1987. Winter stream conditions and use of habitat by brook trout in high-elevation Wyoming streams. Trans. Am. Fish. Soc. 116:176-184. Example of recent emphasis on winter habitat studies and documentation of changes in habitat use during winter. That is, habitat suitability curves made for a species at other times of the year may not apply to winter period.

Federal Register, Oct. 6, 1987. Contains downlisting of Gila trout, Salmo gilae, from endangered to threatened. The only Arizona population, introduced into Gap Creek, is located in the "Cedar Branch Wilderness Area of Prescott National Forest." No critical habitat is listed for this species.

Hillman, T.W. and S.S. Griffith. 1987. Summer and winter habitat selection by juvenile chinook salmon in a highly sedimented Idaho stream. Trans. Am. Fish. Soc. 116:185-195. Another paper emphasizing winter habitat distinctions and limitations of habitat models based on summer observations.

Hughes, R.M. and J.R. Gammon. 1987. Longitudinal changes in fish assemblages and water quality in the Willamette River, Oregon. Trans. Am. Fish. Soc. 116:196-209. Fish species associations studied from headwaters downstream (from low to high stream order) to test predictive accuracy of index of biotic integrity and "index of well-being." As with most other similar studies, it was found that to increase predictive accuracy of IBI, site-specific modifications are necessary.

Matthews, W.J. and D.C. Heins (eds.). 1987. Community and evolutionary ecology of North American stream fishes. Univ. Okla. Press. Contains 32 papers on community ecology (predator-prey, competition, habitat, flow, etc.) of stream fishes, including paper on Arizona fishes by Minckley and Meffe. A useful reference for instream flow considerations.

Miller, R.R. and L.A. Fuiman. 1987. Status of Cyprinodon macularius eremus, a new subspecies of pupfish from Organ Pipe Cactus National Monument, Arizona. National Park Coop. Res. Unit, Univ. Ariz. Tech. Rep. 24. The desert pupfish population of Quitobaquito Spring is described as a new subspecies. As the "whole" species of C. macularius is listed as endangered, the naming of two new subspecies has no effect on status of the species. Provides review of current distribution of species.

Minckley, W.O. and G.K. Meffe. 1987. Differential selection by flooding in stream fish communities of the arid American Southwest. Pages 93-104 in Matthews and Heins (cited above). Evidence is presented that unregulated rivers with natural flood events favor native Arizona stream fishes over non-native species. Table presents data on Salt River above Roosevelt and below Stewart Mtn. Dam, Verde River below Bartlett Dam and on Sycamore Creek near Fort McDowell.

Nelson, R.W., J.R. Dwyer, and W.E. Greenberg. 1987. Regulated flushing in a gravel-bed river for habitat maintenance. A Trinity River fisheries case study. Environ. Mgt. 11:479-493. Damming and diversion of most of flow from Trinity River, California, resulted in sedimentation of stream channel and great reduction in spawning success for salmon and trout. No mitigation measures appear to be safe or cost effective.

Proceedings of Desert Fishes Council, Volumes 16-18. 1987. Most of the current activities of fisheries studies and programs of rare fishes of the southwest are presented at annual meetings of the Desert Fishes Council. These volumes contain articles on squawfish, razorback sucker, spike dace, loach minnow, spinedace, Gila topminnow and pupfish. One article by J.E. Johnson reviews the history of stocking experimental non-essential squawfish, razorback sucker and woundfin (Plagopterus argentissimus) in Salt and Verde drainages.

U.S. Fish and Wildlife Service. 1987. Endangered Species Technical Bull. 12(9). This issue contains an article on reintroduction of Colorado squawfish in Arizona. Since 1985, 176,386 squawfish stocked in Verde and Salt rivers; 100,000 more planned for autumn 1987. Plans for expanding stocking to include Colorado River between Imperial and Parker dams.

U.S. Fish and Wildlife Service, National Ecology Center. Memorandum (Nov. 6, 1987) on update of legal and institutional affairs related to wetlands and instream uses of water. Literature review of current court cases and decisions and activities of state and federal agencies related to policy and precedent of water and wetland uses.

Valdez, R.A., P.B. Holden, T.B. Hardy, and R.J. Ryel. 1987. Habitat suitability curves for endangered fishes of the upper Colorado River basin. Final report submitted to USFWS, Nat. Ecol. Cent. This document represents the final effort to develop habitat curves for use with IFIM for upper Colorado River endangered fishes. Lack of agreement and a multitude of problems and questions raised on validity has led the USFWS to abandon IFIM as a decision-making tool for Colorado River fishes.

BIMONTHLY REPORT: FISHERIES AQUATIC BIOLOGY
November-December 1987
Robert Behnke

Instream Flow, Habitat Issues

I attended the Desert Fishes Council meeting in Hermosillo, Mexico, in November. Papers were presented on attempts to use IFIM for developing flow recommendations (after which, I was invited to present my paper on the Illusion of Technique). Many problems frustrated any definitive conclusions except for a remark by the FWS biologist in charge of the studies that "IFIM is no damn good" and that the habitat suitability curves made for squawfish and other species (cited under Valdez et al. in bibliography) are examples of "cartooning". ~~I~~ mentioned in my critique of instream flow methodologies, that as rivers ~~come out~~ leave ~~of~~ stable channels in canyons ~~and out~~ enter onto unstable floodplains, the channel morphology can be expected to change from year to year or after each flood event, so that any river channel section quantified for IFIM studies to establish "weighted usable area", ~~would~~ should be expected to change in the future. This phenomenon was ~~validated~~ indeed found in IFIM studies on the Green River. The same river section measured at precisely the same flow, gave very different WUA values from one year to the next because the channel had changed configuration.

Another aspect of explaining lack of predictive accuracy of IFIM discussed in my critique concerned seasonal differences in habitat use. ~~Recently, it~~ In relation to this, several recent studies were made of fish habitat use during winter (citations in bibliography to Chisholm et al. and to Hillman and Griffith). ~~In~~ Squawfish winter studies in the Yampa River have been made ~~by~~ during 1985, 1986, 1987, by C.S.U. graduate student Ed Wick. Mr. Wick began his work with ~~the~~ goal of developing habitat suitability curves

Because of the obvious empirical problems encountered for the use of IFIM, FWS administrators have decided that IFIM will not be used for decision-making regarding flows for endangered species.

A FWS spokesperson at the meeting blamed most of the problems with IFIM on inappropriate use or misuse, but admitted it is labor intensive and expensive, and that flow-habitat relationships measured at one point in time is only one of many factors that influence fish populations (obviously true, but previously not admitted). Major emphasis for "selling" IFIM now appears to be to package it as a negotiating tool (see enclosure on course announcement).

for squawfish winter habitat for use with IFIM ('the physical habitat simulation component or PHABSIM). It was found that squawfish mainly live in off channel habitat (backwaters, embayments, side channels) during the winter and that characterizing the river channel for WUA bears no relationship to ~~who~~ the habitat actually used by squawfish. It was also found that ice cover markedly affects USGS gaging stations by raising water levels which may give a flow reading up to 50% above actual flow.

~~Endangered Species~~

Also in November, I participated in a two week ~~a~~ ~~to~~ stream habitat course sponsored by the U.S. Forest Service, held at C.S.U. The course contained several valuable presentations on ~~the~~ current research in hydrology and river mechanics.

Endangered Species

The bibliographic citation to the Federal Register re. Gila trout, reveals a location for Gap Creek (the only Arizona population of S. gilae) as in the Cedar Branch Wilderness Area of Prescott National Forest. Note that no "critical habitat" was listed for S. gilae. The Endangered Species Act calls for listing of "critical habitat" at the time of listing, "to the extent prudent". The USFWS has been instructed not to list critical habitat for any new listings (which may bring on legal action). Each species of plant and animal that has been listed as endangered or threatened in recent months, in the federal register, has a different explanation why it is "not prudent" to list critical habitat. The Gila trout was on the USDI endangered species list prior to the ~~[illegible]~~ passing of the 1973 Endangered Species Act and was grandfathered

ORIGINAL INVOICE

Robert Behnke
3429 E. Prospect Rd.
Fort Collins, CO 80525
Dec. 31, 1987

GILA RIVER ADJUDICATION

To: Salt River Project
C/o M. Byron Lewis
Jennings, Strouss & Salmon
111 West Monroe
Phoenix, AZ 85003-1791

Re. Services, expenses for bimonthly report and annotated bibliography.

2.5 days x $300/day. . . - -	$750.00
typing, xeroxing . . . -	$10.00
TOTAL	$760.00

SRP

For Sept - Oct. | Jan - Feb.

C. J. F. A. S. - seen 44 (1, 2, 3, 5) 4, 6 check

~~De~~Environ. Biol. Fish. QL614 E58

Water Res. Bull. GB651 W315

Environ. Mgt. HC68 E575

+ GB1627 G8J68

HC79 E5J68

Environ. Conserv. QH540 E57

Grt Lks Res - 12(4): 304-13

J. Fish Biol.

J. Freshw. Ecol. QH96 A1J67

Regulated Rivers + (Kemper, J.B. & J. Craig (eds)) Regulated Streams - Advances in Ecology - see Scott and Shirvell. critique I.F. Meth.

Freshwater Biol.

Fish. Res. SH1/F819

Drottningholm SH287/D73

see * ~~Hughes~~ & Gammon 1987 - Longitudinal changes in fish assemblages and water quality in the Willamette River, Or. T.A.F.S. 116: 196-209

Johnson, J. E. 1987. Protected fishes of the United States and Canada. Spec. Publ. Am. Fish. Soc.

color photos of some rare AZ fish -- Gila topminnow, Desert pupfish, loach minnow, spikedace, Gila chub, Little Colo. spinedace, Gila trout.

T.A.F.S. 116 1987. 1. Karr et al. 1-11

2. Baltz et al 12-20

3. Lanka et al. 21-28

USFWS ① I F Chronicle (enclosed- ① enclosure

Shirvell. (author of "Pitfalls ...")

② Memo - ... July ...

Enclosure: review on instream ...

- West. AFS
Ⓐ- instream flow ... -
Ⓑ-enclosure fish screens-

Discussion — —

Memo . Diane Ballade - Mike Moore-

- Hydrology - . emphasis high instream - ...

flows - ... Job 86 rpt. Verde fish Fort McDowell

- Clearly understand non ... need storage for instream flow

~~Wat~~ - Regulated Rivers

- Symp. vol. -

Baltz
Johnson
Karr
Lanka
Moretz
Orth
Shirvell . -87 .
White

BIMONTHLY REPORT, FISHERIES - AQUATIC BIOLOGY

Sept. - Oct. 1987

I reviewed the summary report of Index of Biotic Integrity studies and testing of project funded by EPA (Miller et al. in ~~sta~~ bibliography). Also cited are two papers (Layher et al. and Wesche et al.) that concern attempts to refine ~~and~~ and modify FWS habitat models to attain better predictive accuracy (make model show significant positive correlation between habitat suitability indices and the target species biomass). To do this, however, requires intense effort (and expenses) which impose obvious limits ~~to~~ for practical application.

One of my objectives has been to supply personnel involved with the Gila River Adjudication sufficient basic information in my reports to "fight brush fires" as they might arise (for example, Bill Warskow's response to Arizona Instream Flow Task Force's recommendation to institutionize IFIM as the official Arizona method). To continue to contribute toward this objective, I ~~have~~ enclosed a reprint of Orth, "Ecological considerations in the development and application of instream flow-habitat models" (cited is July-Aug. bibliography). This paper is a good review of the limitations inherent for IFIM studies. The author does, however, hold out hope that with further complexity and effort predictive accuracy can be improved. The above cited papers by Layher et al. and Wesche et al., do indeed, support Orth's hope of improved model accuracy with more intense effort, but also raise the obvious question -- at what cost? (What should be kept in mind is that all of these authors have been funded by USFWS and it is to their benefit to keep hope alive and keep funding coming in).

Also enclosed is a copy of a paper by Fryer, "Quantitative and qualitative: numbers and reality in the study of living organisms". This paper ~~[illegible]~~ reiterates many of the points I have attempted to get across in my various SRP reports. Although much of the paper is directed at professionals aquatic biologists, several key concepts need only common sense to understand. The major objection raised is what I have called the danger of the substitution of numbers and data for thinking, judgement, and biological reality; which essentially explains why IFIM models and similar simplistic habitat models do not work.

Also enclosed is copy of the Instream Flow Chronicle cited in bibliography. As mentioned in last bimonthly report, this official organ of IFIM has dramatically downplayed the ~~form~~ "pie in the sky" type of articles it formerly featured. If one reads the headline story, the obvious question that comes to mind is; why is a model needed in such a simple situation where all that must be known is how much flow in the stream channel covers dinosaur tracks?

The enclosed two pages xeroxed from the Autumn 1987 issue of Trout Magazine, describes a stream improvement project on Canyon Creek conducted by Trout Unlimited. Bill Warskow had inquired ~~abo~~ on the status of a proposed study by Arizona St. Univ. on the trout fishery of the Verde River. ~~Two~~ About three years ago, Bill Davies (mentioned in article) formed "Anglers United" in Arizona and the Verde trout project was planned. ~~I was~~ Bill ~~informed~~ Davies and Anglers United are now ~~not~~ part of Trout Unlimited. The Verde river study was too costly ($30,000) and was never initiated but the Canyon Creek project was undertaken instead.

ANNOTATED BIBLIOGRAPHY, SEPT.-OCT., 1987

Fryer, G. 1987. Quantitative and qualitative: numbers and reality in the study of living organisms. Freshwater Biol. 17: 177-189. This paper "formalizes" many of the points I have attempted to make in my SRP reports concerning limitations of predictive models and dangers (and expense) of their naive acceptence. Copy enclosed.

Layher, W.G., E. Maughan, and W.D. Wande. 1987. Spotted bass habitat suitability related to fish occurrence and biomass measurements of physicochemical variables. N. Am. J. Fish Mgt. 7: 238-251. In relation to enclosed reprint by Orth on instream-flow-habitat models, which holds out hope that better accuracy can be achieved with more intense study and more complex models, this article might tend to support Orth's conclusion, but at a price! With intense effort and manipulation a predictive correlation was developed for the bass and its habitat, but it is only site-specifically applicable (only to site intensively studied). Obviously, the time and costs involved to make site-specific models for each species for specific river sections for ~~a~~ basin-wide flow ~~consid~~ 'adjudication' would be make any improvement of predictive accuracy infeasible.

Meulemann, G.A., H.J. Hansen, and R.C. Martin. 1987. Wildlife protection, mitigation, and enhancement plans - Anderson Ranch and Black Canyon facilities. Final Rep. to Bonneville Power Adm. The Northwest Power Act of 1980, set an interesting precedent (limited to Columbia R. basin) of retroactive mitigation, which directs the BPA to protect, mitigate and enhance wildlife to the extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries. The costs of mitigation are to be paid for by hydropower revenue. The hydro-irrigation projects for which mitigation-enhancement were developed in this report were completed in 1923 and 1950 (i.e. prior to 1958 Fish and Wildlife Coordination Act which mandates that equal consideration be given to fish and wildlife with all other purposes of project]. An obvious problem concerns how can the wildlife values lost to reservoir construction of 40-60 years ago be quantified. A "game" was played using Habitat Units (HU) for various wildlife species (USFWS' Habitat Evaluation Proceedures, or HEP), and 'guessing' how many ~~on~~ HU's for each species there might have been prior to ~~underlying the reservoir~~ reservoir construction (now underlying the reservoirs).

Miller, D. L. and 13 other authors, 1987 (unpublished). Regional applications of an index of biotic integrity for use in water resources management. This manuscript, prepared for publication, was sent to me for review. It summarizes the work on application of the Index of Biotic Integrity (IBI) funded by the EPA. It must be recognized that James Karr, who developed the IBI, was essentially directing and guiding all of the studies carried out (~~by~~ mainly by his former students and associates). Thus, as expected, the contents of this report are highly favorable to IBI as the best biological monitoring method. It is suggested that for the Southwest, with a sparse native fish fauna (fish species diversity are main metrics to establish IBI scores), the ratio of native to non-native fishes might be used as an indicator of degradation or environmental change (non-native fishes dominate most of Gila-Salt basin)

Moss, D., M. T. Furse, J. F. Wright and P. P. Armitage. 1987. The prediction of the macroinvertebrate fauna of unpolluted running water sites in Great Britain using environmental data. Freshwater Biol. 17: 41-52. An up-to-date review of various aspects of biological monitoring, especially in relation to detecting catastrophic events such as pesticide pollution.

U.S. Fish & Wildlife Service. 1987. Endangered Species Tech. Bull. 12(7). Only Arizona species mentioned is final listing of Mt. Graham squirrel as endangered.

BIBLIOG (Cont)

USFWS. 1987. Instream Flow Chronicle, Oct. 87. Copy enclosed. Note 'headline' article describing how IFIM was used in attempt to resolve problem in Texas (not yet resolved), of maintaining sufficient flow to cover dinosaur tracks. The obvious question is: why is a model needed for such a simple cause-and-effect relationship (flow to cover tracks)? All that is necessary is to gage stream and record flow at depth that covers the desired part of stream channel.

USFWS. 1987. Update of legal and institutional affairs related to wetlands and instream flow uses of water, memorandom of Sept. 14, 1987. ~~Cy~~ Contains update on the Instream Flow Information System, "STRATEGIES".

Wesche, T. A, C. M. Goertler, and W. A. Hubert. 1987. Modified habitat suitability index model for brown trout in southeastern wyoming. N. Am. J. Fish Mgt. 7:232-237. Brown trout populations were studied in 30 sections of 9 streams. No significant correlation between brown trout biomass and FWS' Habitat Suitability Indices (HSI) were found. ~~By~~ With intense study and modifications and additions of habitat variables to the model, a significant, but weak (R=.52) correlation was made. The significance of this work, similar to the Loyher, et al. paper cited above, is that habitat models require intense work with site-specific fine-tuning to obtain even weak predictive capabilities. The implications for large-scale or basin-wide assessments in regards to time and expense are obvious.

BIMONTHLY REPORT: FISHERIES, AZUATIC BIOLOGY
January-February 1988
Robert Behnke

Bill Warskow called me last month to invite to attend with him, a program for a University of Colorado School of Law seminar scheduled for March 31 - April 1, 1988 entitled: "Instream Flow Protection in the Western United States: A Practical Symposium." I have just received from Bill information (1) on the conference and have made arrangements to make these dates free to attend.

The manuscript by Conder and (2) Annear (Wyoming Game and Fish Dept.) concerning the lack of predictive accuracy of IFIM (lack of correlation between weighted usuable area "WUA" and trout biomass) that was used as evidence for Arizona discussions last year in regards to selection of an official state methodology, has been published (cited in bibliography). Although modified and reorganized from the draft version, the evidence presented is convincing that any degree of predictive accuracy requires site-specific data. This led me to look into the matter of "between stream" differences in relation to implications for standard habitat models or monitoring methods. Several citations are provided to demonstrate site-specific differences in regards to habitat preference or association, diversity, and even for impacts to riparian vegatation from flow depletion. A general truism might be stated from these studies to the effect that there can be no such thing as a "standard" habitat-species association model applicable to a range of different environments. Predictive accuracy of any such model depends on moditication with site-specific data.

The Colorado-Wyoming Chapter of the American Fisheries Society will hold its annual meeting in Fort Collins, March 2,3. A special session will be devoted to "habitat estimation and use."

(1) - I've sent in reservations for conference

(2) - Note on conference program that Annear is one of participants.

ANNOTATED BIBLIOGRAPHY

Angermeier, P.L. and I.J. Schlosser. 1987. Assessing biotic integrity of the fish community in a small Illinois stream. N. Am. J. Fish. Mgt. 7:331-338. Index of biotic integrity (IBI) compared with Shannon-Wiener diversity index to test predictive accuracy to detect stream degradation. As expected (the authors are IBI peoplė), the IBI was the better predictor. The authors conclude that the breadth of information incorporated into IBI makes it a more useful monitoring tool to detect degradation.

Conder, A.L. and T.C. Annear. 1987. Test of weighted useable area estimates derived from a PHABSIM model for instream flow studies on trout streams. N. Am. J. Fish. Mgt. 7:339-350. This paper was previously cited in my reports as a manuscript. The published version is modified, but conclusions are same. Weighted Usable Area (WUA) of the USFWS incremental methodology (IFIM) was calculated for different sites in several streams. Then comparisons were made of actual trout biomass and WUA values between different sections of the same stream and between different sections of the same stream and between different streams. The correlation coefficients between WUA and trout biomass between different streams was near zero or negative. Within stream comparisons showed some weak positive correlations when velocity was the controlling factor. Conclusion is that for streams of different character, IFIM cannot be used to predict trout biomass (for ex., Powder River and Laramie River had same WUA values, yet Powder R. had more than four times the biomass per unit area--due to factors not considered in computing WUA).

Grossman, G.D., M.C. Freeman, P.B. Moyle and J.O. Whitaker. 1985. Stochasticity and assemblage organization in an Indiana stream fish assemblage. Am. Nat. 126:275-285. I reread this paper to review concepts of predictability of fish communities in relation to deterministic (predictable) and stochastic or random (unpredictable) influences that affect species diversity and abundance. The greater the stochastic influence, the less predictive are such methodologies such as IBI and IFIM. See Meffe and Minckley below regarding stability of fish fauna in Aravaipa Creek, Arizona.

Grossman, G.D., A. De Sostoa, M.C. Freeman and J. Lobon-Cervia (in press, two papers reviewed) Microhabitat use in a Mediterranean riverine fish assemblage : I, Fishes of the lower Matarrana, II, Fishes of the Upper Matarrana. Papers submitted to Oecologia. Grossman reports on his studies of habitat preference by fish species in a Spanish River. He found more "deterministic" influences on habitat preference, but these "preferences" varied between streams (verifying the Conder and Annear conclusions that models based on species-habitat relationships lack predictive reality in between streamcomparisons).

Kondolf, G.M. J.W. Webb, M.J. Sale and T. Ferlando. 1987. Basic hydrologic studies for assessing impacts of flow diversions on riparian vegetation: Examples from streams of the eastern Sierra Nevada, California. Environ. Mgt. 11:757-769. Geomorphic and hydrographic peculiarities of each stream prohibits the development of a "standard method" to predict riparian impact of flow depletion--as discussed above for habitat models, site-specific data is needed.

McHenry, M.L. 1986. A test of the habitat quality index in forested headwater streams of the Gila National Forest, New Mexico. M.S. thesis, New Mexico St. Univ.-Using a model similar to the Wyoming model developed by Allen Binns (HQI), relatively good agreement was achieved between predicted (by HQI) and actual biomass of Gila trout (23-31% error)--note that the model was site-specifically fine-tuned.

Meffe, G.K. and W.L. Minckley. 1987. Persistence and stability of fish and invertebrate assemblages in a repeatedly disturbed Sonaran desert stream. Am. Midland Nat. 117:177-191. The fish community has remained stable in Aravaipa Creek over many years despite great fluctuations in flow (to 70,000 cfs during Oct. 1983 flood). Aravaipa Creek contains mainly native Gila River species including the threatened loach minnow (Tiaroga) and spike dace (Meda). The implication is that unregulated Arizona streams subjected to great natural flow fluctuations favor the persistence of native species.

Sidle, J.G. 1987. Critical habitat designation: Is it prudent? Environ. Mgt. 11:429-437. Only 23% of species federally listed as endangered or threatened have had critical habitat designated. Many reasons are given but mainly, there is less opposition to listing if critical habitat is not included.

U.S.F.W.S. Update of legal and institutional affairs related to wetlands and instream flow uses of water. Review of recent court cases on the subject.

U.S.F.W.S. Habitat Evaluation Notes, vol. 1, no. 1, Feb. 1988. A new companion bulletin to Instream Flow Chronicle issued by the F.W.S. Habitat Evaluation Procedure (HEP) group. Mentions some Habitat Suitability models (Habitat Suitability Index curves used both by IFIM and HEP) are being tested, including one for smallmouth bass by Arizona Cooperative Fishery Unit.

U.S.F.W.S. Instream Flow Chronicle 4(4) Jan. 1988. Reports on survey of participants of IFIM courses. "No connection could be seen between the number of courses taken and the self-perceived competency of the participants to use IFIM".

Wallher, P. 1987. Against idealistic beliefs in the problem-solving capacities of integrated resource management. Environ. Mgt. 11: 439-446. A few years ago, "Integrated Resource

Management" methodology was touted as a tool for resolving conflicts by..."increasing organization and order in a system and integrating cooperative decision making". The author cites examples to show it's really not so. From my experience with IRM, I would agree.

BIMONTHLY REPORT FISHERIES - AQUATIC BIOLOGY

March - April 1988

I attended the Colorado - Wyoming fisheries society meeting, March 2, 3. Papers given on habitat models, relationship of streamflow, trout fry habitat and year-class strength of trout populations and one by R.T. Milhous (USFWS, Instream Flow Group) on physical habitat - aquatic population relationships. An assumption of IFIM is that a fish population is limited by habitat and that IFIM methods accurately characterize habitat relationships controlling a population. Mr. Milhous concluded after much review of the subject that there is only a "reasonable" relationship between a population's abundance and its physical habitat, but even then it's "far from simple" (see enclosed critique of FWS Coordination Report on Two Forks Project).

March 31, April 1, attended Instream Flow Workshop with Bill Warskow at the Univ. Colorado, Boulder. I told Bill that I was reviewing a FWS Coordination Act Report on the Two Forks Dam project (Denver Water Board) and would write a critique of the report for ~~the~~ my bimonthly report because it illustrates how the unnecessary use of IFIM as a "negotiating" tool" can be very costly for a developer. As noted in the enclosed report, an enormous amount of IFIM studies were undertaken for the EIS and for the Coordination Report, which do not, and cannot adequately assess mitigation (replacement of 36,500 pounds of a gold medal (Colo. Div. wildlife designation) wild trout fishery. The ironic aspect of the matter is that the mitigation matter of "replacement" had already been "resolved". The Denver Water Board had agreed to guarantee a 90% replacement of the lost biomass by flow manipulations and habitat improvements on other waters. So why was all of this needless IFIM work done? Could the money have been better spent elsewhere?

Chadwick and Associates (~~an~~ consulting firm I frequently work with) did the aquatic biology - fisheries studies for the Denver Water Board and the total charges for the work to date is about $500,000 -- a considerable part of this is for IFIM studies. I expect to see a future article in one of the journals telling the story of how IFIM, as a "negotiating tool", helped to resolve the conflict of Two Forks Dam.

~~In~~ In my critique, the problem of "within" and "between" comparisons of rivers, highlighted in ~~the~~ my Jan.-Feb. report, is delineated. ~~I~~ With a bit of reflection on the matter, I believe this problem should be readily apparent, but nothing in the Two Forks Coordination Act Report indicates it was recognized, much less understood.

ANNOTATED BIBLIOGRAPHY

Mar - Apr 1988

Bleed, A. S. 1987. Limitations of concepts ~~used~~ to determine instream flow requirements for habitat maintenance. Water Res. Bull. 23(6): 1173-78. Concludes that all endeavors have failed concerning prediction of effects of changing flows on wildlife habitat of Platt River, Nebraska, because it is an alluvial river with a changing channel morphology.

Cavendish, M. G. and M. I Duncan. 1986. Use of Instream Flow Incremental Methodology: a tool for negotiation. Envrion. Impact Assessment Rev. 6: 347-63. Concerns ~~proposed~~ changes in flow of James River, Missouri and how IFIM was used to predict impacts on several fish species. The success of IFIM for conflict resolution is touted (the senior author is FWS employee with the Instream Flow Group), but the accuracy of predicted impact on fish fauna is unknown. As an afterthought, the authors conclude: "It would be of interest to study the existing fishery resource to see whether or not the negotiated settlement did, in fact, protect it."

~~Graham~~ Granholm, S., S. Li, and B. Holton. 1985. Warning: use IFIM and HEP with caution. Hydro Rev. 4(4): 22-28. Critiques problems of IFIM and HEP to conclude: "A real grasp of what IFIM and HEP can do, and what they can't do, is a essential for today's hydro developer. Without it, he or she will be at the mercy of inexperienced or biased evaluation team members".

Morhardt, J.E. and E.G. Altourney. 1985. Instream ~~flow~~ requirements: what is the state of the art? Hydro Rev. ~~4~~(4): 66-69. A brief summary of large report prepared for Electrical Power Research Institute by Morhardt (1986).

Orth, D.J. and R.M. Leonard. 1987. An approach for recommending minimum stream flows for Virginia streams. Vir. J. Sci. 38(2): 122. IFIM used on 9 species of fish in 4 ~~st~~ streams. In regards to optimum flows for target species, ~~it was found~~ expressed in percent of average daily flow, it was found that in larger streams optimum flows are achieved at lower % of ADF than in smaller streams (which likely is result of gradient differences).

U.S. Fish and Wildlife Service

Endangered Species Tech. Bull. 12(11-12) contains article on progress of Gila trout recovery effort.

"Memo on recent developments related to instream flows and wetlands (March, 1988). ~~Rev~~ Reviews of Indian tribes' water rights and fishing rights and "tax" on water depletion in upper Colorado River basin to fund endangered species work.

cc HDR

Jacobs, K.E., W.D. Swink, and J.F. Novotny. 1987. Minimum tailwaters flows in relation to habitat suitability and sport-fish harvest. N.A.J.F.M. 7(4): 569-574.

Use "Newcombe" method - several sp. RB trout Tailwater fr. model WUA or H.V. ab. slow and most frequent caught "validating" model - but trout are stocked monthly.

Newcombe, C. 1981. A procedure to estimate change in a fish populations caused by changes in stream discharge. T.A.F.S. 110(3): 382-390.

Essentially IFIM - but fewer measurements, at dif. flows (no

B.C. hydraulic model) and only depth & velocity - 2 sections of stream (reaches) studied 1. broad 2. narrow - both impact. for salmon and trout.

data at 1m intervals along 6 transects (3 per reach) and

* measured at 5 flows - .2 - 2.2 m^3/sec. 7 - 80 cfs. velocity measured 12 cm (6 in) from bottom - 1 m. units - uses IFIM

substrate no use any way except spawning

HSI curves for sp. for depth & velocity - * Compare w/ Tennant method & * expert (objective) judgement (biologist anglers thorough familiar w/ river)

- depth & velocity change uniform - substrate composition (visual function of velocity at any section (reach) -

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Instream Flow Chronicle 5(1). article on technical assistance for IFIM studies.

Habitat Evaluation Notes 1(2). Journal of FWS touting HEP, contains article on "reducing effort in a HEP study".

BIMONTHLY REPORT: FISHERIES - AQUATIC BIOLOGY

May - June 1988

In the ~~M~~ March - April report I highlighted the enormous expense a ~~devel~~ water development project might be subjected to from demands of federal and state agencies in regards to habitat quantification and habitat modeling, using the Two Forks Dam controversy as an example. ~~My~~ The point I emphasized was that ~~despite~~ no matter how much is spent for habitat assessment, quantification, and modeling, no increased benefits are apparent for predictive accuracy or for the target species of fish because the models are so inherently limited to begin with.

The bibliographic citations to Bovee and Zuboy and to Jakle and Barrett ~~will enclosed copy of title page and index to publication~~ refer to a workshop held by the U.S. Fish and Wildlife Service to discuss problems of developing habitat suitability criteria for use with IFIM (Instream Flow Incremental Methodology). A reading of these papers makes one aware of the potential for great (and often needless) expense ~~fo~~ of environmental assessment work. The paper by Jakle and Barrett concerns their attempt to predict impacts to the "threatened" spikedace, _Meda fulgida_, in the Verde River from proposed diversions. Through 1986, more than $30,000 had been spent on attempts to quantify spikedace habitat and each additional field trip costs $540. Yet the most fundamental question concerning spikedace in the Verde River -- are depth and velocity the major controlling factors of the spikedace population? (for ex., what about competitive and predation interactions with non-native fishes?) -- has yet to be raised by the ~~people~~ agencies doing the work. That is, a million dollars worth of depth and velocity measurements on spikedace in the Verde River would likely provide ~~do~~ little benefit to spikedace unless more fundamental facets of their total biology and life history were known.

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A maxim to keep in mind is that needless busy work will expand to the limits of funding. If one million dollars were to be made available for Verde River spikedace studies, it is likely that a million dollars would be spent on depth and velocity measurements and ~~sp~~ sophisticated treatment of data -- and the basic questions in need of answers concerning the actual limiting factors would still not be asked.

In relation to the expansion of busy work to the limits of funding, a copy of the March, 1988, Endangered Species Technical Bulletin is enclosed. This issue discusses the plans for recovery efforts for upper Colorado River basin endangered fish species. Of special significance for future water development projects in the West is a precedent setting multi-agency agreement that ~~costs~~ ~~will~~ ~~self perpetuating~~ will be funded by a water depletion tax of $10 per acre foot and the expenditure of about 10 million dollars for the acquisition of water rights. The total budget for the "recovery" efforts is 33 million dollars (in addition to millions already spent).

The funding of "recovery" efforts began about 10 years ago when the Bureau of Reclamation gave one million (later increased to two million) dollars to the USFWS for "research" on endangered fishes so that Bureau projects would not be in violation of the Endangered Species Act (A memorandum of ~~to~~ understanding mentions that by 1981 the FWS ~~will~~ would have all the needed knowledge to manage the endangered species so that Bureau projects will be in compliance with the Act). In 1981, under orders from Interior Secretary James Watt not to issue jeopardy opinions, the FWS ~~to~~ initiated their depletion payment scheme for nonjeopardy opinions ($10 per acre foot). The rationale was that although the project as proposed, would jeopardize the continued existence of endangered species, if a certain amount was paid to the USFWS for "research",

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jeopardy would be avoided because of the knowledge gained from the research. After the first few million dollars were spent, and now with an additional 33 million budget, besides the hatchery propagation and stocking of ~~the~~ squawfish, no real benefits have resulted to the endangered species -- but great amounts of habitat assessment, quantification, modeling and monitoring, employing many people has resulted.

Indeed, the recovery plans developed by the USFWS during the past ~~ten~~ 10 years have reflected the fact that "work" expands to the limit of funding (the latest squawfish plan calls for annual expenditures, exclusive of hatchery propagation, of $700,000) -- but I have seen no indication that the endangered species are better off today than they were 10 years ago.

The conclusion that can be drawn is that the resolution to fisheries - water development conflicts is not so much a matter of ~~more~~ The amount of money spent but rather a matter of ~~more~~ The quality of the thinking involved.

ANNOTATED BIBLIOGRAPHY

May - June, 1988

Bovee, K. and J. R. Zuboy (eds.) 1988. Proceedings of a workshop on the development and evaluation of habitat suitability criteria. U.S.F.W.S. Biol. Rep. 88(11): 407p. Contains 22 papers presented at a workshop devoted to discussing problems of establishing reliable habitat suitability indices (HSI) for IFIM models. Copy of cover and titles enclosed.

Fausch, K.D., C.L. Hawkes, and M.G. Parsons. 1988. Models that predict standing crop of stream fish from habitat variables: 1950-85. U.S. Forest Service Gen. Tech. Rep. PNW-213. ~~GTR~~ A total of 99 models, proposed from 1950 to 1985, for quantifying stream habitat variables and relate these variables to fish populations were reviewed. Statistical and biological limitations of the models are discussed. For example, the inability of such models to address non-habitat variables such as competition and predation as significant factors determining species abundance.

Jackle, M.D. and P.J. Barrett, 1988. A statistical approach to determining sample size for species habitat preference curves. Pages 21-30, in: Bovee and Zuboy (see above). Concerns costs to develop data on habitat of the spikedace, _Meda fulgida_, in Verde River for IFIM model to predict impacts from proposed stream diversions. To the end of 1986, more than $30,000 had been spent and each additional field trip to obtain more data (still inadequate) cost $540.

Platts, W.S. and M.L. McHenry. 1988. Density and biomass of trout and char in western streams. U.S. Forest Service Gen. Tech. Rep. INT-241. A compilation, by regions, of literature reports on trout biomass in streams. This can be a useful document for obtaining ~~an~~ regional average and range of biomass based on ~~for~~ many streams. In a case ~~[illegible]~~ with which I am currently involved, the consultant for the state claimed a stream, ~~so~~ without heavy metal impact should have more than 300 lbs. of trout per acre (based on outrageously improper use of a habitat model), whereas, with heavy metals, the stream contains only contains about 55 lb./acre (therefore ~~damage~~ impairment from heavy metals causes a loss of about 250 pounds per acre). This publication lists ~~mo~~ data from more than 100 trout streams in the Rocky Mountain region. The range of biomass reported is about 20 to 150 lbs./acre with a mean of about 50 -- thereby exposing the fraudulent nature of the state's claim that a Rocky Mountain trout stream should sustain 300+ lbs/acre if not impaired.

U.S. Fish and Wildlife Service, Endangered Species Technical Bull. 1988, 13(3). Discusses the ~~plans~~ enormously expensive plans for saving endangered fishes of the upper Colorado River basin (Copy enclosed).

Wakeley, J.S. 1988. A method to create simplified versions of existing habitat suitability (HSI) models. Environmental Management 12(1):79-85. Adresses the problem of excessive costs to obtain data for habitat suitability criteria (as ~~are~~ discussed in Jockle and Barnett, above). The Corps of Engineers developed ~~more~~ simplified criteria by converting contenuous variables into discrete variables to reduce time and expense of habitat assessment.

ORIGINAL INVOICE

Robert Behnke
3429 E. Prospect Rd.
Fort Collins, CO 80525

June 30, 1988

GILA RIVER ADJUDICATION

To: Salt River Project
c/o M. Byron Lewis
Jennings, Strouss & Salmon
111 West Monroe
Phoenix, AZ 85003-1791

Re: Services May 1 - June 30, 1988. Preparation of bimonthly report and annotated bibliography.

~~3~~ 2.5 days x $300/day	$750.00
typing, xeroxing	10.00
TOTAL	$760.00

BIMONTHLY REPORT: FISHERIES-AQUATIC ~~ANNOTATED BIBLIOGRAPHY~~ BIOLOGY

July - August, 1988

An understanding of the limitations of any model or method to accurately assess impacts is basic for any agency desiring to avoid wasteful expenditures on needless busy work. Such an understanding does not require formal education in biology or ecology. Common sense ability for reviewing all of the evidence to arrive at a judgement, is the most important attribute. Some understanding of human belief systems or mind sets can also be important to comprehend why certain people or agencies ~~insist~~ support a discredited or unreliable assessment method. Although, oversimplified, two types of mental processes can be identified: 1. Holistic - synthesizing all information to assess interactions of various parts of the whole, not in isolation, but as integral parts of the whole (for ex. an ecosystem). Such thinking can be creative, innovative, insightful, and constructive. 2. Reductionist - imitative formulation, ~~of previous~~ following of rules, unquestioning belief in authority, in tradition. Reductionist thinkers typically have a naive faith in "science" or in the "scientific method", without an ~~under~~ in depth understanding of what science is all about. They approach an ecosystem problem, such as assessment of impacts from a changed flow regime, ~~with the same faith~~ by use of a standard method, with the same faith an engineer might have in ~~the~~ following a method based on ~~the~~ laws of physics for constructing a bridge or a dam. They have little or no concept of the basic difference ~~in~~ between the laws of physics and biological phenomena in relation to conforming to patterns of regularity in nature. Reductionist thinkers, typically have little understanding of a species niche, which is "n" dimensional (unlimited number of environmental influences) and dynamically changes in relation to age, season, coexisting

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species in the community, etc. If they did better comprehend the niche concept of a species, they would lose faith in the ability of any method that ~~a~~ measures a very few dimensions of a niche at any one time, putting the data into a model, and expect a deterministic, accurate prediction of how the species will respond to an environmental change.

The above discussion on reductionist thinking, may be a relatively accurate description of the way many administrators in state and federal agencies respond to the problem of environmental assessment. The precise values or numbers generated from a IFIM study displaying gains and losses in habitat of various species from changes in ~~fol~~ flow, ~~is~~ can be irresistable to an administrator, pressed to make a decision. Some may be sufficiently perceptive to realize that the numbers and values are likely to have little or no biological relevance in relation to what the actual changes in populations may be, but the quick fix of "conflict resolution" is overwhelmingly attractive. THUS, the ~~Thus, the~~ USFWS, the lead federal agency for developing models and methods for environmental impact assessment, now realizes the limitations of their major models (IFIM to assess impacts from flow changes and HEP to assess nonflow aquatic changes and terrestrial modifications) to accurately relate model values ~~—~~ to meaninful biological realities (for ex., weighted usable area or WUA values to a species biomass) and ~~now~~ currently emphasize ~~that~~ ~~—~~ the primary value of IFIM or HEP is as "negotiating tools" rather than biological predictors.

The problem is that many agencies require IFIM studies for any assessment dealing with flow changes. These ~~were~~ requirements were established during a period when many, if not most, biologists and administrators had a naive faith that IFIM was an accurate predictor of fish biomass (a belief that WUA values are directly related to species biomass). The blind acceptance of this false assumption ~~and~~ resulting in an "official standard method" ~~can~~ cause a squandering of funds with no benefits to the intended fish species. The bibliographic citation to Geer 1987, relates to the fact that the Utah Department of Wildlife resources has adopted IFIM as the state's "official" method for flow-habitat impact studies (Bill Geer is now Director of the Utah Department), and suggests what would have been the likely outcome in Arizona if the instream flow subcommittee had their way last year.

Geer describes IFIM studies to be conducted in 16 precise steps. Major fish species and "invertebrates" are ranked in importance and after ~~the~~ analyses is completed through the 16 steps, "best" flow values are derived (but with consideration of historical monthly flows to arrive at acceptable flows). Geer's paper is a classic example of reductionist thinking and the administrative mind set. Before one gets to "step one", serious consideration (holistic thinking) should have been given to questioning the assumptions on which the model is based. Does WUA accurately reflect all attributes of the environment affecting trout, whitefish, and invertebrates? The answer, we now know, is that it does not. What, then, do the final values, derived after the 16 steps are completed really mean, besides that much money was spent and a conflict "resolved"?

If the State of Utah were to be challenged in court on their "official" state method and the plaintiffs had knowledgable attorneys and experts, the outcome would be an ~~[illegible]~~ embarrassment. Although much fault and erroneous components can be found in the Utah model on a step by step critique, the basic premises and

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assumptions on which the model is based are false to begin with. One substantitive falsity ~~can be dlles~~ is obvious in Geer's figure 2 in which two separate and different ~~habitat~~ WUA curves ~~are~~ presented to represent "spawning" and "egg incubation" in relation to flow changes. What one must assume from this is that one site in the stream is "best" for a trout to deposit its eggs, another ~~~~ site with different characteristics is "best" for the eggs to develop. ~~Evolutions~~ In an evolutionary ~~sense,~~ perspective, this would be an impossibility. Those fish that put their eggs in the best sites to yield maximum survival to hatching, leave the most offspring (to pass on the best adapted genotypes). Thus, there can not be two separate criteria for "best" spawning and "best" incubation in the same stream. It might be argued that what is really intended is a "time series" analysis, that egg incubation follows spawning, thus there is a different flow during for each event. Analysis of the ~~curv~~ figure and the text, however, does not imply that such thinking went into the model -- it is simply based on a "follow the rules" & a false assumption.

~~It~~ Analysis of Geer's exposition of the Utah standard method, leads to a conclusion that a much more biologically relevant assessment could have been made with much less time, effort, and costs. This would be by applying the rule of parsimony or the weakest link, "bottleneck" strategy to the analysis. Look for the most limiting, simple cause-and-effect factor that determines population abundance and relate that to flow. For example the paper cited by Nehring and Miller (1988) touts the efficacy of IFIM to predict year-class abundance of trout in the Gunnison River, Colorado. The fact of the matter is that Mr.

Nehring, from long experience and sampling of the Gunnison River learned that the critical period in the life cycle of Gunnison trout affected by river regulation, was at the time the young emerged from the gravel and for the following several weeks. He arrived at this conclusion by comparing sampling data with USGS flow records. It became obvious that if flows were higher than normal, the year-class was greatly reduced because they were swept away be high velocity flows. Nehring incorporated these empirical observations into an IFIM model which quantifies this quite nicely -- but only because it represents an example of a weakest link or bottleneck situation. There is no need for a model ~~except~~ in ~~to~~ such situations to understand flow impacts, except as a "communications" device or a "negotiating" tool for administrators who are easily deluded by the illusion of technique.

The citation to Gore and Nestler 1988, ~~to~~ refers to a paper defending the use of IFIM (mainly as a "negotiating tool"). The authors admit that: "predicting changes in biomass from IFIM studies exceeds the current state of the art".. and that IFIM was not meant to simulate, "ecological interactions". They add: "The implied relationship between WUA and fish biomass is the most serious misconception of the IFIM procedure." ~~A good~~ If this is true, how, then, did this misconception originate and become propagated (or propagandized)? In a paper published in 1978, K.D. Bovee, the person most intimately involved with development of IFIM, made the following statement: "Although the incremental method was designed primarily to assess changes in standing crop and species composition due to changes in flow regimes, several other applications of the method have been identified." Here is a clear statement

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on the primary purpose of IFIM -- to predict changes in standing crop (= biomass) and species composition (= ecological interaction among different species). Now that it is realized that the ~~p~~ original primary purpose ~~is~~ cannot be achieved, the "other applications" (communications and negotiations) have become "primary", but the printed words can't be expunged (Bovee, 1978. The incremental method of assessing habitat potential for coolwater species, with management implications. Pages 340-346 in: Selected Coolwater Fisheries, Am. Fish. Soc. Spec. Pub. 11).

~~It~~ would be a similar situation if, in 1978, a spokesperson for ~~Ford~~ or General Motors had announced that they had developed a ~~motor~~ car generating 100 horsepower and getting 100 miles per gallon. After years of failures in numerous tests, in 1988, they announce that ~~the~~ primary purpose was ~~never~~ not 100 hp and 100 mpg, but "other applications".

~~BIMONTHLY REPORT: FISHERIES-AQUATIC BIOLOGY~~ ANNOTATED BIBLIOGRAPHY

July - August, 1988

~~B~~Bozek, M.A. and F.J. Rahel. 1988. Habitat use by young-of-the-year Colorado River cutthroat trout in the North Fork Little Snake River, Wyoming. Proc. CO-WY Chapter Am. Fish. Soc. 23:71-75. In relation to water diversion project, this study focused on the "weakest link" strategy to predict impacts of potential flow changes by quantification of sites most used by young fish.

Burton, G. 1988. Recovering the threatened Apache trout and endangered Gila trout in Arizona and New Mexico. Proc. 67th Ann. Conf. West. Asc. Fish and Wildlife Agencies: 361. ~~This~~ Discusses restoration of the two trout species and propagation of Apache trout at the Alchesay-Williams Creek National Hatchery. At this year's Western F.&W. meeting in Albuquerque, large Apache trout (3-5 lbs.) from the hatchery were displayed live in a tank.

Duff, D.A. 1988. Implementing a fish-habitat relationship program through GAWS (General Aquatic Wildlife System). Proc. 67th Ann. Conf. West. Asc. Fish and Wildlife Agencies: 313-316. Describes U.S. Forest Service attempt to use models relating potential impacts from various conflicting uses. For example, one model relates livestock impact on streams to fish production, one inserts the Wyoming HQI (Habitat Quality Index) model, relating ~~habitat~~ habitat components to fish biomass; H.S.I (Habitat Suitability Index ~~Curves~~) can also be used for predicting sediment impacts. The "validity" or empirical demonstration of the efficacy of GAWS is not discussed -- evidently, as with IFIM, its main value is for negotiation and conflict resolution.

Gee, W.H. 1987. A method for treatment of data from the Instream Flow Incremental Methodology for instream flow determination. Pages 1-25, in: J.F. Craig and J.B. Kemper (editors) Regulated Streams. Plenum Pub. Corp. This paper is discussed in bimonthly report to illustrate problems when a specific methodology (IFIM) is declared to be ~~the~~ "official" ~~or only~~ by a state agency.

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Gore, J. A. and J. M. Nestler. 1988. Instream flow studies in perspective. Regulated Rivers 2(2): 93-101. This paper, which, "in perspective" states that the most serious misconception of IFIM is to believe there is a relationship between WUA (weighted usable area) and fish biomass, is discussed in bimonthly report.

Hillman, F.W., D.W. Chapman, and J.S. Griffith. 1988. Summer and winter ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report to the Chelan Co. P.U.D., Don Chapman Consultants. I cite this work as a good example of ~~attempting~~ attempting to understand fish-habitat relationships based on two years of detailed underwater observations. The complexities of intra and interspecific interactions of behavorial, competitive and predator-prey relationships on a daily and seasonal basis are well-revealed and makes clear why a quantitative model based on a few habitat components such as depth and velocity (while ignoring the complex interactions and ontogenetic changes that influence habitat use) can not begin to accurately reflect what is going on in nature.

Hydro Review. Scanned the 1988 issues of this journal and noted emphasis on fishery problems and dams and a review in each issue of current research sponsored by the Electric Power Research Institute (EPRI) which continues to fund research on instream flow methods.

Kozel, S. J. and W. A. Hubert. 1988. Changes in habitat features and trout abundance with increasing stream size among unaltered stream reaches. Proc. CO-WY Chapter Am. Fish. Soc. 23: 76-81. Habitat-trout biomass relationships in unaltered streams were associated to gradient classes and depth, width-depth ratio, undercut banks, cover. Funded by U.S. Forest Service.

Milhous, R.T. 1988. The physical & aquatic population relationship. Ibid: 108. Mr. Milhous (US FWS) helped to develop IFIM. He here states the obvious, but which was not recognized during the early years of IFIM promotion, that although any fish species requires suitable habitat, the presence of good habitat does not mean that a species will be there because of "other factors" (such as food).

Nehring, R.B. and D.D. Miller. 1988. The influence of spring discharge levels on rainbow and brown trout recruitment and survival, Black Canyon of the Gunnison, Colorado, as determined by IFIM/PHABSIM models. Proc. 67th Ann. ~~Meet.~~ Conf. West. Asc. Fish and Wildlife Agencies: 388-397. This paper defends the validity of IFIM by demonstrating good correlations between WUA values and survival of newly hatched trout. Although though this is true, it applies to a situation of a "weakest link" simple cause-and-effect of determination of recruitment into a population (degree of survival of young fish). When flows are high during emergence of the young trout from the redds, they cannot tolerate the velocity and are swept away and lost to population. Although IFIM application correctly detects this event (because Nehring fine-tuned his HSI curves to specific critical sites), an examination of USGS flow records would also be an accurate predictor of recruitment in the Gunnison R.

Pajak, P. and R.J. Neves. 1987. Habitat suitability and fish production: a model evaluation for rock bass in two Virginia streams. Trans. Am. Fish. Soc. 116(6): 839-850. HSI model for rock bass tested in many sections of two Virginia streams to correlate rock bass biomass with HSI values. No correlation was found.

Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in southern Ontario. Can. Jour. Fish. Aquat. Sci. 45(3): 416-423. Example of modifying IBI to conform to local conditions.

Taylor, E.B. Water temperature and velocity as determinants of microhabitats of juvenile chinook and (4) coho salmon in a laboratory stream. Trans. Am. Fish. Soc, 117(1): 22-28. Quantification of ~~how~~ habitat "preference" changes in response to changing conditions (as demonstrated in a ~~under~~ natural environment ~~conditions~~ by study of Hillman et al. cited above).

U.S. Fish and Wildlife Service. 1988. Nat. Ecol. Cent. Instream Flow Memo (July 15). Mentions federal-state and interstate compact for purchasing water rights in upper Colorado River basin for endangered species (see enclosure A for details).

USFWS, Final Environmental Assessment Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. Provides details for spending $5 million of federal and $27.5 of state funds for "recovery" of squawfish, bonytail, and humpback chub. Much of the funds expected to be derived from a $10 per acre foot depletion payment ~~from~~ from water development projects.

USFWS, Recovery Implementation Program for Endangered Fish Species in the upper Colorado River Basin. ~~$~~ Strategy for "recovery" of endangered fishes in 15 years, spending $33 million. Ten years ago, USFWS spokespersons claimed that after spending one million dollars (later raised to two) donated by Bureau of Reclamation, and with two years of "research", endangered species problems in upper Colorado River basin would be taken care of (everything needed to be known for "recovery" to be available by 1981!).

BIMONTHLY REPORT: FISHERIES - AQUATIC BIOLOGY
July-August, 1988

An understanding of the limitations of any model or method to accurately assess impacts is basic for any agency desiring to avoid wasteful expenditures on needless busy work. Such an understanding does not require formal education in biology or ecology. Common sense ability for reviewing all of the evidence to arrive at a judgment is the most important attribute. Some understanding of human belief systems or mind sets can also be important to comprehend why certain people or agencies support a discredited or unreliable assessment method. Although, oversimplified, two types of mental processes can be identified: 1. Holistic-synthesizing all information to assess interactions of various parts of the whole, not in isolation, but as integral parts of the whole (for ex. an ecosystem). Such thinking can be creative, innovative, insightful, and constructive. 2. Reductionist-imitative formulation, following of rules, unquestioning belief in authority, in tradition. Reductionist thinkers typically have a naive faith in "science" or in the "scientific method" without an in-depth understanding of what science is all about. They approach an ecosystem problem, such as assessment of impacts from a changed flow regime by use of a standard method, with the same faith an engineer might have in following a method based on laws of physics for constructing a bridge or a dam. They have little or no concept of the basic differences between the laws of physics and biological phenomena in relation to conforming to patterns of regularity in nature. Reductionist thinkers, typically have little understanding of a species niche, which is "n" dimensional (unlimited number of environmental influences) and dynamically changes in relation to age, season, coexisting species in the community, etc. If they did better comprehend the niche concept of a species they would lose faith in the ability of any method that measures very few dimensions of a niche at any one time, putting the data into a model, and expect a deterministic, accurate prediction of how the species will respond to an environmental change.

The above discussion on reductionist thinking, may be a relatively accurate description of the way many administrators in state and federal agencies respond to the problem of environmental assessment. The precise values or numbers generated from a IFIM study displaying gains and losses in habitat of various species from changes in flow, can be irresistible to an administrator pressed to make a decision. Some may be sufficiently perceptive to realize that the numbers and values are likely to have little or no biological relevance in relation to what the actual changes in populations may be, but the quick fix of "conflict resolution" is overwhelmingly attractive. Thus, USFWS, the lead federal agency for developing models and methods for environmental impact assessment, now realizes the limitations of their major models (IFIM to assess impacts from flow changes and HEP to assess nonflow aquatic changes and terrestrial modifications) to accurately relate model values to meaningful biological realities (for ex., weighted usable area or WUA values to a species biomass) and currently emphasize that the primary value of IFIM or HEP is as "negotiating tools" rather than biological predictors.

The problem is that many agencies require IFIM studies for any assessment dealing with flow changes. The requirements were established during a period when many, if not most, biologists and administrators had a naive faith that IFIM was an accurate predictor of fish biomass (a belief that WUA values are directly related to species biomass). The blind acceptance of this false assumption resulting in an "official standard method" can cause a squandering of funds with no benefits to the intended fish species. The bibliographic citation to Geer 1987, relates to the fact that the Utah Department of Wildlife Resources has adopted IFIM as the state's "official" method for flow-habitat impact studies (Bill Geer is now Director of the Utah Department), and suggests what would have been the likely outcome in Arizona if the instream flow subcommittee had their way last year.

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The citation to Gore and Nestler 1988, refers to a paper defending the use of IFIM (mainly as a "negotiating tool"). The authors admit that: "predicting changes in biomass from IFIM studies exceeds the current state of the art" ... and that: "IFIM was not meant to simulate ecological interactions." They add: "The implied relationship between WUA and fish biomass is the most serious misconception of the IFIM procedure." IF this is true, how, then, did this misconception originate and become propagated (or propagandized)? In a paper published in 1978, K. D. Bovee, the person most intimately involved with development of IFIM, made the following statement: "Although the incremental method was designed primarily to assess changes in standing crop and species composition due to changes in flow regimes, several other applications of the method have been identified." Here is a clear statement on the <u>primary</u> purpose of IFIM -- to predict changes in <u>standing crop</u> (= biomass) and <u>species composition</u> (= ecological interaction among different species.) Now that it is realized that the original primary purpose cannot be achieved, the "other applications" (communications and negotiations) have become "primary", but the printed words cannot be expunged (Bovee, 1978). The incremental method of assessing habitat potential for coolwater species, with management implications. Pages 340-346 in: Selected Coolwater Fisheries, Am. Fish. Soc. Spec. Pub. 11).

It would be a similar situation if, in 1978, a spokesperson for Ford or General Motors had announced that they had developed a car generating 100 horsepower and getting 100 miles per gallon. After years of failures in numerous tests, in 1988, they announced that the primary purpose was not 100 hp and 100 mpg, but "other applications".

ANNOTATED BIBLIOGRAPHY

July-August, 1988

Bozek, M. A. and F. J. Rahel. 1988. Habitat use by young-of-the-year Colorado River cutthroat trout in the North Fork Little Snake River, Wyoming. Proc. CO-WY Chapter Am. Fish. Soc. 23:71-75. In relation to water diversion project, this study focused on the "weakest link" strategy to predict impacts of potential flow changes by quantification of sites most used by young fish.

Burton, G. 1988. Recovering the threatened Apache trout and endangered Gila trout in Arizona and New Mexico. Proc. 67th Ann. Conf. West. Asc. Fish and Wildlife Agencies: 361. Discusses restoration of the two trout species and propagation of Apache trout at the Alchesay-

Williams Creek National Hatchery. At this year's Western Fish and Wildlife meeting in Albuquerque, large Apache trout (3-5 lbs.) from the hatchery were displayed live in a tank.

Duff, D. A. 1988. Implementing a fish-habitat relationship program through GAWS (General Aquatic Wildlife System). Proc. 67th Ann. Conf. West. Asc. Fish and Wildlife Agencies: 313-316. Describes U.S. Forest Service attempt to use models relating potential impacts from various conflicting uses. For example, one model relates livestock impact on streams to fish production, one insets the Wyoming HQI (Habitat Quality Index) model, relating habitat components to fish biomass; H.S.I. (Habitat Suitability Index) can also be used for predicting sediment impacts. The "validity" or empirical demonstration of the efficacy of GAWS is not discussed -- evidently, as with IFIM, its main value is for negotiation and conflict resolution.

Geer, W. H. 1987. A method for treatment of data from the Instream Flow Incremental Methodology for instream flow determination. Pages 1-25, in: F. J. Craig and J. B. Kemper (editors). Regulated Streams. Plenum Publ. Corp. This paper is discussed in bimonthly report to illustrate problems when a specific methodology (IFIM) is declared to be "official" by a state agency.

Gore, J. A. and J. M. Nestler. 1988. Instream flow studies in perspective. Regulated Rivers 2(2):93-101. This paper, which, "in perspective" states that the most serious misconception of IFIM is to believe there is a relationship between WUA (weighted usable area) and fish biomass, is discussed in bimonthly report.

Hillman, F. W., D. W. Chapman, and J. S. Griffith. 1988. Summer and winter ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report to the Chelan Co. P.U.D., Don Chapman Consultants. I cite this work as a good example of attempting to understand fish-habitat relationships based on two years of detailed underwater observations. The complexities of intra and interspecific interactions of behavioral, competitive and predator-prey relationships on a daily and seasonal basis are well-revealed and makes clear why a quantitative model based on a few habitat components such as depth and velocity (while ignoring the complex interactions and ontogenetic changes that influence habitat use) cannot begin to accurately reflect what is going on in nature.

Hydro Review. Scanned the 1988 issues of this journal and noted emphasis on fish~~ing~~ery problems and dams and a review in each issue of current research sponsored by the Electric Power Research Institute (EPRI) which continues to fund research on instream flow methods.

Kozel, S. J. and W. A. Hubert. 1988. Changes in habitat features and trout abundance with increasing stream size among unaltered stream reaches. Proc. CO-WY Chapter Am. Fish. Soc. 23:76-81. Habitat-trout biomass relationships in unaltered streams were associated to gradient classes and depth, width-depth ratio, undercut banks, cover. Funded by U.S. Forest Service.

Milhous, R. T. 1988. The physical aquatic population relationship. IBID: 108. Mr. Milhous (USFWS) helped to develop IFIM. He here states the obvious, but which was not recognized during the early years of IFIM promotion, that although any fish species requires suitable habitat, the presence of good habitat does not mean that a species will be there because of "other factors" (such as food).

Nehring, R. B. and D. D. Miller. 1988. The influence of spring discharge levels on rainbow and brown trout recruitment and survival, Black Canyon of the Gunnison River, Colorado, as determined by IFIM/PHABSIM. Proc. 67th Conf. West. Wildlife Agencies: 388-397. This paper defends the validity of IFIM by demonstrating good correlations between WUA values and survival of newly hatched trout. Although this is true, it applies to a situation of a "weakest link" simple cause-and-effect of determination of recruitment into a population (degree of survival of young fish). When flows are high during emergence of the young trout from the redds, they cannot tolerate the velocity and are swept away and lost to population. Although IFIM application correctly detects this event (because Nehring fine-tuned his HSI curves to specific critical sites), an examination of USGS flow records would also be an accurate predictor of recruitment in the Gunnison River.

Pajak, P. and R. J. Neves. 1987. Habitat suitability and fish production: a model evaluation for rock bass in two Virginia streams. Trans. Am. Fish. Soc. 116(6):839-850. HSI model for rock bass tested in many sections of two Virginia streams to correlate rock bass biomass with HSI values. No correlation was found.

Steedman, R. J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in southern Ontario. Can. Jour. Fish. Aquat. Sci. 45(3):416-423. Example of modifying IBI to conform to local conditions.

Taylor, E. B. Water temperature and velocity as determinants of microhabitats of juvenile chinook and coho salmon in a laboratory stream. Trans. Am. Fish. Soc. 117(1):22-28. Quantification of habitat "preference" changes in response to changing conditions (as demonstrated in a natural environment by study of Hillman et al. cited above).

U.S. Fish and Wildlife Service. 1988. Nat. Ecol. Cent. Instream Flow Memo (July 15). Mentions federal-state and interstate compact for purchasing water rights in upper Colorado River basin for endangered species (see enclosure A for details).

USFWS, Final Environmental Assessment Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. Provides details for spending $5 million of federal and $27.5 million of state funds for "recovery" of squawfish, bonytail, and humpback chub. Much of the funds expected to be derived from a $10 per acre foot depletion payment from water development projects.

USFWS, Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. Strategy for "recovery" of endangered fishes in 15 years, spending $33 million. Ten years ago, USFWS spokespersons claimed that after spending one million dollars (later raised to two) donated by Bureau of Reclamation, and with two years of "research", endangered species problems in the upper Colorado River basin would be taken care of (everything needed to be known for "recovery" to be available by 1981!).

TAFS · 1989 MacFadden

(1986)

Jakle & Barrett – re Verde R. ~~study~~ predict impacts from proposed stream diversions : re spikedace, Meda fulgida.

How # can be run up endlessly / 1st rept. 25 re Two Forks

only if all agree to play by rules + Hab. unit = play $

– How much data needed to make HSI curve – ?

– each field trip + gather data costs $540

> $30,000 already spent. – ex. statistical confid. that .2 or .3 cfs optim velocity –

* need for naturalist – thinking – most direct cause-effect

* Confuse quantif. – data w/ knowledge – biol. realism

admit – "biol. judgement" needed – bottom line ..

common sense – intuition & judgement –

Impossibility of accurately defining all attributes of habitat and interaction – – angler & intuition know where most large trout are

but – holistic vs. incremental – disjunct step-in. depth, veloc. etc. =

as Shakespeare abstract. – thus – what flows 'optimize' – .

– undercut bank – debris jams – & hydraulic model = what depth &

optimize – ~~visibility~~ – day-night – daily – seasonally – complexity – vs. one step – one facet highly precise.

Last month – re Two Forks mitigation – enormous expenses involved for habitat quant. modelling w/ no demonstrab. real benefits because lack of predictive accuracy – Aim to hydrol. attorney.. not be

wasted $ what development agency in for it – USRP unaware

master biol. impl – but common sense – re. human mind and esp. organizational – agency mindset – Two basic types thinking analysis of problem 1. Holistic, synthetic, construction creative, innovative – logic or simple – conceptual

2. Reductionist – analyze quantitative, data – imitative – follow strict rules, formulas : data vs. knowledge biol. realism – prof. judgement.

– Mention Bureau 2 by pub of paper by Jacle (Bur. Rec.) & Barrett (USFW, (member of Ariz. subcomm. for instream flow) and – .. spike dace all efforts to establish valid habitat crite. for fish simply (sam. bass) – not recognized ignored – but overall non-flow factors such as predation so limit pop in ~~for ex. no matter~~ what factors – flow – holistic flow coexist or favor w/ sm. bass or competitor non-native sp.

precedents will be set for future flow end. sp. conflicts

~~If habitat~~ USFS – contrast AZ-NM – factors that ban if factors well in models established – why seek to reinvent wheel? – observ not known model not predictive (Jacle & Barrett) – Also whole book Streamfish Comm – no need for symp & publ. if already so well established that predictive model can be develop

– YET stifled agencies continue to demand enormous & wasteful expenditures for water development project for useless, needless, research data gath (follow bureaucrat reductionist mindset)

– Ex. – Color. R. End. Sp. (bull excl.) – – – – – – –

books Reg. Streams, Impounded Rivers.

Scty-to appeal etc

— McConnel review for ideas

Aquatic comm

Common Sense — to understand, predict fish pop, insect chngs w/ few simple measurements — why so many nyup. proc. vol.? vol. on arithmetic 2+2=4 — manual for contract pandora etc —

· USFS Tempe & N.M. & Ariz. Trout streams — est. density biomass and habitat features — compare habitat to biomass — delineate what factors more impt.

~~Cit IFIM assumption correction~~ —

— Ex, Otter Crk. nelson club BT RB before after fencing

— decision making — values, no. — unpredictable

but pure trout > worm ws

sp. how much ?? —

— Ruedi Dam Frying Pan, Myers 5.X incre

no flow changes — <200 c ..

— Niche volumes — redside - steelhead temp

5 4 9 & prod. 21/ ..

— Frying Pan R. & 5X biomass

BIMONTHLY REPORT
Sept. - Oct. 1988

In the July-August report I raised the issue of why agencies adopt a standard method for environmental assessment and prediction of consequences of a proposed action such as a change in stream flow, when the standard method is known to be lacking in predictive accuracy. "Standardization" can be so alluring to the administrative mindset in a belief that it brings order out of choas, that it can become an obsession in itself and considerations on the question if the standard method is doing the job it is supposed to do, or if it is the best method, are ignored. I also pointed out that although the current official position of the USFWS on its IFIM and HEP simulation models is that they cannot accurately predict changes in abundance, biomass, or species composition associated with environmental changes such as flow, they are very useful for communication and negotiation. I also cited a reference from 1978 clearly demonstrating that 10 years ago, the USFWS was indeed selling these programs on the basis that the primary purpose of their IFIM model was to predict changes in biomass and species interactions with flow changes. That is, agency administrators were misled into accepting a standard method on a false premise, but now it is too late to turn back.

It is obvious that confusion and controversy surrounds the issue of a standard method for environmental assessment and, as such, a situation is created whereby hasty and ill-informed decisions can be made. In the bibliography I cite several references that demonstrate the complexity and the interactions of biotic (living organisms) and abiotic (physical, chemical phenomena such as habitat structure, temperature, oxygen, etc.) factors that determine the abundance and distribution of a fish species--and why a simplistic model incorporating only a few abiotic (habitat) components can not be expected to function as an "ecosystem" model with accurate predictions. There is also a citation to Scott and Shirvell protesting the uncritical and dangerous use of IFIM in New Zealand. I met with Dr. Scott several years ago in Fort Collins when he was here to learn more about IFIM from USFWS personnel. At the time he was optimistic about a standard method that could be applied for water projects in New Zealand. The article by Scott and Shirvell tells of their disillusionment with the results. They state: " No relationship between fish production and WUA has been demonstrated for before and after flow changes", and that, agencies enforcing the use of IFIM did so under the mistaken assumption that there was a statistically valid basis for predictions.

On the other side of the spectrum of controversy I cite Nehring's recent presentation to the annual meeting of the American Fisheries Society. Nehring is a vocal proponent of IFIM and he is recognized as a highly competent fisheries biologist. Nehring's contention is that all negative publicity concerning IFIM is due to "misuse". Obviously, then, the present state of affairs makes it difficult for an agency to arrive at an informed decision on the matter of a "standard" method. For example if the matter is again raised in Arizona, it is likely that IFIM proponents would introduce the highly laudatory statements of Nehring as evidence in support of IFIM as the official state standard method. Before the great differences between the pros and cons of the efficacy of IFIM can be resolved or understood, it is necessary to refine and define more clearly the bases used by various workers to form their favorable or unfavorable opinions.

We have here a situation analagous to comparing apples and oranges. They are both "fruit". Thus, a certain person may love apples and hate oranges and contradictory statements of equal validity could be made that this person loves "fruit" and hates "fruit". Resolution of this "controversy" is not apparent until apples and oranges are recognized as separate categories of "fruit".

If the basis for Nehring"s favorable conclusion on IFIM are critically examined a similar resolution to the IFIM "conflict" becomes apparent. What Nehring did was essentially use "professional judgement" based on his experience with regulated rivers and trout populations, to establish baseline data on year-class abundance years with U.S.G.S. flow records to observe what flows, at what periods cause failure of a year-class. The determinant of year-class abundance in this situation is a classic "bottleneck" in the life history of trout with a certain period of time (within the first four weeks after emergence of the baby trout from the gravel) when river flows with velocities above a critical level cause great loss of the year-class. That is, a clear-cut relationship between velocity (and the flows that produced the velocity) and year-class strength was established. Once the "results" are documented of this relationship, the data is calibrated into the PHABSIM model of IFIM and IFIM "looks good" as an accurate predictor of year-class strength--but in reality no such model is necessary for such a simple cause-and-effect relationship; merely a graph or table depicting flows during critical (bottleneck) periods with an index of year-class abundance does the same thing (but with less sophistication and less illusion of technique, which may indeed be of importance for communication and negotiation).

The citations to Marotz et al. (1988) and to Nelson (1984) are examples where IFIM could be made to look good if it was used. Marotz et al. used a wetted perimeter method to determine flows needed for spawning fish to negotiate shallow riffle areas and Nelson correlated USGS flow records to compare and correlate various permutations of monthly flow records with trout abundance. In both cases, after the results are known and correlations well-documented, these correlative data could have been incorporated into PHABSIM models and, "after the fact", IFIM would "look good." This would be a far cry, however, from making a claim that IFIM is an accurate predictor of species abundance and interspecific interactions for all life history stages related to flow changes. The disillusionment with IFIM expressed by Scott and Shirvell is valid--IFIM is not an accurate predictor of the conesequences to a fish population from changes in flow, unless a specific bottleneck situation with a tight cause-and effect relationship with flow can be documented, as was done by Nehring. But in such cases simulation models are notnecessary for understanding the relationship. The apparent efficacy of IFIM in Nehring's work is due to the "after the fact" analysis--the answere were already known before the flow-habitat relations were entered into the model. Sort of like betting on the world series after it is over. If one could find enough naive people to make such bets, he would get a reputation as an accurate predictor.

ANNOTATED BIBLIOGRAPHY
Sept. - Oct. 1988

Beecher, H.A. 1987. Simulating trout feeding stations in instream flow models. P. 71-82, in: J.F. Craig and J. B. Kemper (eds.) Regulated Streams. Plenum Press. Ex. of use of professional judgement to demonstrate the precise area in a stream used by trout for feeding is the "shear zone" boundary between higher and lower velocity currents. That is, although a large area of a stream may have similar average depths and velocities and thus have same WUA values for modelling, it is a tiny microhabitat area, the shear zone, where most feeding occurs.

Bjornn, T. C. 1988. Densities and habitat use of newly emerged chinook salmon in streams as related to cover and fish predators. Abstracts of 118th Ann. Meeting Am. Fish. Soc: 90. The use of habitat by chinook salmon fry (position of individual fish in relation to depth, velocity, substrate, cover) was completely different between observations with and without potential predators. That is, if completely accurate habitat suitablity indices were recorded for use in IFIM or HEP modelling, there would be dramatic differences in "habitat suitability" for the same fish in the same site, depending on the presence or absence of potential predators. The author concluded: " These results are illustrative of the need to include all factors that regulate abundance and habitat use in models such as the Instream Flow Incremental Methodology (IFIM) and Habitat Evaluation Proceedures (HEP)".

Elliot, S. T. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Trans. Am. Fish. Soc. 115: 392-400. This paper illustrates the significance of "habitat" factors that affect a fish population but which cannot be adequately quantified for predictive purposes. When "woody debris" (stumps, logs, branches) were removed from a stream (in accordance with state law to clean-up after a logging operation) the abundance and biomass of aquatic insects suffered a great decline, followed by a decline in the trout population. When woody debris again became part of the stream habitat, insects and trout greatly increased in abundance. How can "woody debris" be introduced into a habitat model? Studies such as this should make biologists aware how little of the important habitat parameters affecting fish abundance can be incorporated into a model by depth, velocity, and substrate measurements alone (basis of WUA of IFIM).

Kelly, M., S. Moore, and S. V. Gregory. 1988. Response of young-of-the year cutthroat trout to manipulation of habitat structure in a small stream. Trans. Am. Fish. Soc. 117: 162-170. The complexity and area of stream margins greatly influences the abundance of cutthroat trout in their first year of life (determination of year-class strength). Another example where professional judgement is needed because almost all stream margin areas have similar depths, velocities, and substrates (same WUA), but abundance is actually determined by subtle structural complexities of the type overlooked by simplistic habitat models.

Marotz, B., B. Hansen, and S. Tralles. 1988. Instream flows needed for successful migration and rearing of rainbow and cutthroat trout in selected tributaries of the Kootenai River. Final Rep. to Bonneville Power Adm. The "old fashioned" wetted perimeter method for instream flow recommendations was used to predict flows that would provide necessary depths for adult fish to ascend through riffle areas of tributary streams and to adequately flood riffle areas for food production for young fish. The relatively few point measurements to yield a "stage-flow" relationship is much simpler and much less time comsuming than the 100's of such measurements across transects needed for IFIM study to yield same results. The point is, that, as was done by Barry Nehring, such simple measurements of one or two (depth and/or velocity) can be incorporated into the PHABSIM model of IFIM and IFIM could get the credit for successful results.

Nehring, R.B. 1988. Influence on stream discharge levels on rainbow and brown trout recruitment and survival in ten Colorado trout streams as determined by IFIM/PHABSIM models. Abstracts of 118th Ann. Meeting Am. Fish. Soc: 28. Nehring points out that the critical period for determining year-class strength in trout populations is during the two to four week period after the fry emerge from the gravel. In regulated rivers, too high a flow (too high velocity) can essentially wipe out a year-class. Nehring used "professional judgment" over several years by correlating USGS flow records and year-class strength. Working "backwards" then he incorporated critical velocities into PHABSIM model of IFIM (see last bimonthly rept.) to make IFIM "look good". The point to be recognized is that Nehring found a classic life history "bottleneck" situation which has a tight cause and effect relationship between stream velocity and trout survival during their early life stage. As such, no "model" is necessary unless it might be used for negotiation and communication. Because of his success in predicting year-class strength with flows, Nehring has become the most outspoken defender of IFIM, although he already had documented the cause - effect relationship before IFIM was ever applied--that is, IFIM was used as an after-thought to illustrate the obvious.

Nelson, F. A. 1984. Some trout - flow relationships in Montana. Wild Trout III Symposium Proceedings: 122-126. This Montana study is very similar to Colorado work reported by Nehring cited above. To compare relationships between trout abundance and biomass in several regulated rivers, various correlations were checked between minimum monthly flows at various times of the year and juvenile and adult abundance. Some good correlations were found to pinpoint where and when flow below a critical level severely impacted trout populations. These correlations, once tested and demonstrated to be valid, can be incorporated into PHABSIM/IFIM model (as was done by Nehring) to make IFIM "look good". This was not done in the Montana study; however, the figures depicting the correlations should be sufficienlty clear and understandable for negotiation and communication.

Reeves, G.H., F. H. Everest, and S. D. Hall. 1988. Interactions between redside shiner and steelhead trout in western Oregon: the influence of water temperature. Can. J. Fish. Aquat. Sci: 44 : 1603-1613. This study demonstrates "biotic" factors (interspecific interactions) as influenced by an "abiotic" factor (water temperature) that determine species abundance and biomass (factors not considered in simple "habitat models"). At low (15°C) temperature, the coexistence of redside shiner did not decrease the growth and production of young steelhead trout compared to young steelhead existing without the shiners (but shiner production was greatly affected by presence of trout at low temperature). At high (20°C) temperature, the presence of shiners greatly reduced trout growth and production (but the presence of trout had no affect on shiner production at the higher temp.).

Reiser, D. W. 1988. Summary of instream flow needs and issues in North America. Abstracts of 118th Ann. Meet. Am. Fish. Soc. In 1986, 202 questionaires were sent to state and federal agencies in 50 states and 16 Canadian Provinces. The most common "needs" expressed were the development of new technologies and the validation of existing methods. The most widely applied method is IFIM.

Scott D. and C. S. Shirvell. 1987. A critique of the instream flow incremental methodology and observations on flow determinations in New Zealand. P. 27-43, in: J. F. Craig and J. B. Kemper (eds.). Regulated Streams, Plenum Press. Recounts the disillusionment with IFIM in New Zealand, where, once it became an accepted method (based on false assumptions), IFIM was used by water developers to gain concessions harmful to fish.

U.S.F.W.S. Endangered Species Bulletin. 1988, 13(6-7). Recounts of bald eagle nesting results in Arizona and propagation of Gila trout.

U.S.F.W.S. Instream Flow and Wetland Memorandum (Aug. 31, 1988). Nature Conservancy obtains water rights for instream flow for native fishes in Aravaipa Creek , Arizona. Summary of article by Bonnie Colby re. economic values of instream flow (from vol. 2, no. 5 of Water Market Update, and presented, in part, at April workshop in Boulder, CO). Mentions public trust doctrine invoked in Mono Lake, Calif., case (see enclosure).

AFS - economic issue
value angle day

Library
— Rosen

(1) Beecher :45-57 - shear zone
~~SRP~~ - Irvine, Jowett, & Scott. N.Z. Jour. Man. - Fw Res. ~~Mgt.~~
(2) Bjornn AFS
Irvine - :83-97 - and 5 flow - a (3) Elliot 86 - debris the stream
(4) Marotz, et al 88 - Bonneville (5) Moore & Greg. TAFS 117(2):162
(6) Nehring - AFS Abst. " used -Co. "
(7) Nelson 85 WITIH

Debris in stream
Irvine Nov-Dec.

(8) Reeves et al 88 - Redside shiner
(9) Reiser - AFS Abst.
(10) Scott & Shirvell 87 : 27-43

(11) USFWS • E.S.A. Memo.

Eweliker Ful
- 200 lb/ac
900 lb/ac -

- Date Nels. G. & P. - 1969 - Otter Crk
fenced • livestk - erosion - veg. tables
substrate -
1957-66 - 1% RB, 17% brown,
22% white sucker, 60% crk. chub
nickel volume change
1974-76 - 97% R.B. - 2% br
.5% whit sucker - .5% crk. chub
no environmental changes - enterp. intra
feeding, reproduction, occupation of ...
only livestock removed
HSI - if all precise change in sediment load,
turbidity - temp., channel morph. - subst.
depth, velocity - take HSI models
of RB, BT, W.S., C.C. -
- spawning
- juvenile
- adult
enter before - after data.
time series analysis.

- ~~Last~~ Sub. Ag. rept - mentioned adv mindset - - - ?

- citation ~~Sherwell~~ Scott - N.Z. - - several years ago - not Scott - understand & disillusioned - standard meth - seemed to be accurate prediction - - why not accurate prediction - could recover - - see citation - - - - - -

Recall Test, - other Crk - - " "

now negotiators, ~~commun~~ not ecosystem model - but - indeed 197- touted as such approach

- Yet, widely respected cob Dunn - Bam Nehring - ~~talk~~ closed presentment - ... expressing loyalty to s.l - any event - set stage for ... standard meth - admits controversy but cites Nehring as to efficacy - Problem due to wrong case - - - what Nehring do that makes work? - Confusion due to precisely delineate what aspect of life history - dealt with and if at bottom cause - effect apparent - if so then - O_2 if < 1 ppm - 3 hr. total mortality - model but obvious - Nehring

exp expert'l prof judg - USGS records year-char - velocity.

- Nelson - Mont. same could put in.

- far diff than saying Nehring pin-point ~~effect~~ velocit on brief period on ... - to 4 wks of ... ~~tell to~~ extrapolate ... for all life history Trout in ... R. - -

Library

Bain. et. al. 1988. Streamflow regulation and fish community structure. Ecology 69(2): 382-92.

+ Rosen –

Aquacult. & Fish. Mgt. 19(2): 213-15 intermittent feeding & growth

Can. J. Fish. Aquat. Sci. 44(11): 1820-29 sticklebacks

J. Fish Biol. 32(6): 901-10 Loch Rannoch

Reiser, D. W., M. P. Ramey, and T. R. Lambert. Considerations in assessing flushing flow needs in a regulated stream: 45-57.

re little known about

IFIM - flushing - gravel cleaning (remove fine sand/silt particles ?) -

Wesche, T. A., V. R. Hasfurther, W. A. Hubert, and Q. D. Skinner. Assesment of flushing flow recommendations in a steep, rough, regulated stream: 59-69.

Beecher, H. A. Simulating trout feeding stations in instream flow models: 71 - 82.

- emphasis on microhabitat - feeding station - low velocity / high velocity shear zone

significance not picked up, recorded by IFIM analysis of transects cells.

(small area stream critical - cover resting - feeding - spawning - rearing - overwinter - where bottlenecks.

shear zone = feeding station habitat

- can be incorporated into IFIM study - add to PHABSIM model

- Problem - large rivers. IFIM because velocity predicts very low flows are best.

- suggest feeding station data better for such situations.

Irvine, J. R. - Effects of varying flows in man-made streams on rainbow trout (*Salmo gairdneri*) fry. 83 - 97.

(5 artificial channels) ||||| = no dif. growth, not in daily fluctuation = 5x

Gore, J. A. Development and application of macroinvertebrate instream flow models for regulated flow management: 99 - 116. another ex. of addition to IFIM - model of invert. re. flow.

temp (Jensen: 207 - re constant vs. fluctuating - Elliot (75) no dif. max. rations - Hokanson et al. ('77) JFRBC 34: 639-48 R.B. trout at fluct. temp. opr. $\bar{x}$ 1.5 C° lower than constant.

Petts, G. E. 1984. Impounded rivers: perspectives for ecological management. John Wiley & Sons.

- book on changes in aquatic ecosystem + damming rivers - reservoir & regulating flow - problems - river - fish - fisheries - ex. case history of Trinity R. - Carp

Fontaine, T. D. and S. M. Bartell (eds) 1984. Dynamics of Lotic Ecosystems. Ann Arbor - Science Press.

- many chapters on state of art - theories, principles, concepts - currents used to understand energy flow dynamics of - flowing water

- WE Nehring - why workers - so great
- bottleneck - weak link - simple cause-effect - IFIM necessary?
(work backwards - illustrate obvious
- communication - negotiation
- follow Geer paper

how good prior IFIM - Born

ex. temp. Tailwater 50-60° opp. extend 10 mi. downstream vols increase n due this -

Craig, J. F. and J. B. Kemper (eds.). 1987. Regulated Streams. Advances in Ecology. Plenum Press.

Geer, W.H. 1-27. Utah ex. - Rationale, organization,

O.K. - but habitat criteria relation flow to influence on target ...

overly simplistic - naive - .

Scott, D. and C.S. Shirvell. A critique of the instream flow incremental methodology and observations on flow determination in New Zealand: 27-43.

use of computer for the model simulation concept

- IFIM - several components - simulate temp, pH - water quality
but habitat = PHABSIM - most often used & HSI curves
false assumption - - - often confuse PHABSIM w/ IFIM -

IFIM "uncritical use" "dangerous" "part of framework of developing methods - i.e. use of computer simulation"

PHABSIM - widely used (= IFIM) & institutionalized, legalized as 'standard' method in several state - fed. agencies - done so w/ assumption that HSI = reality :. So widely used on false basis - danger of extensive damage to natural resources if predictions inaccurate.
- Paper to examine validity of PHABSIM assumptions.
I PHABSIM assumptions - depth, velocity, substrate size only habitat parameters determining site selection (prefered habitat) by fish.
- index w/ WUA in relation to flow - but cover obvious input. - discontinuous, no valid quantification of "cover" not amenable for PHABSIM -

predicts depth & velocity Manning equation Hydraulic simulation part of IFIM PHABSIM

critique of 'mechanical' aspects - Manning's equation for vel.

Hydraulic simulation aspects

hydrology - where velocity prediction will be 10-50%. off -
- HSF model incorrectly treats a probability function
- Critique - why PHABSIM - WUA - not not expect) dens. assoc. w/ biomass - why expect predictions to be erroneous - Compare publication of 7 - pos cor 11 no or negative cor

Signif. for use - "No relationship between fish production and WUA has been demonstrated before or after a flow change."
- Agencies enforcing use IFIM assume statistically 95% accuracy of prediction - actually ~ 20%! Too much emphasis on accurate prediction 1 in 20
IFIM predictions of what will happen after flow change.
New Zealand exp. (recall Don Scott ca 1980 - Ft. Collins
IFIM - - Disillusioned - turned on theory - consult. co. misused diversion project ... IFIM to claim too low min. flow in ... river

2

— uncertainty muddling through floundering fluvial re. hydrology — fisheries — engineering — channel type morphol - gradient flow — 'models' methods outstrip basis + knowledge understanding

grouping - understand
Regulated river
attempts to improve
Cent. Utah stream flow
Strawberry
great depletes
how get most out of flow
2 approaches
tried 2 trib.

Kershner, J. L. 1987. Planning habitat improvement projects using a combination of habitat typing and channel typing. ibid: 317-327. - Little Truckee R.

Black, R., R. Cox, J. Romero, R. Williams. 1987. A comparison of stream habitat improvement techniques. Proc. 67th Ann. Conf. West. Asc. Fish & Wildl. Agencies: 328-339.

Anderson, J. W. 1987. The pitfalls & triumphs of planning, designing and implementing habitat restoration in-channel. ibid: 338-3~~52~~46. — Re why improvement projects fail -- administrative problems -

Reichmuth, D. R. 1987. Pitfalls in stream habitat work: 347-352 - President Geomax - prof. engineers - need for in-depth thoughtful planning - understand physical pro limits

~ Desert Fishes Council ~

A F S Economics

IBF
Miller D.L. & 13 other authors 1988 - Fisheries 13(5): 12 -
IBF
Nancy Hoefs, Evaluation of - IBI -
"refinement for loss"
sp. rich -

A.F.S. Abstracts p. 21 - Economics
rec. values - miles, serv. str - res. str - angler day / yr. - $2 1976 $113 1988 CVM
till now way undervalued. - direct cost method. - travel cost
CVM local - st.-wide

Abiotic — Nehring (p. 28) - fry habitat 2-4 wk. after emergence is critical
" IFIM / PHABSIM models are used in Colo. as tool
"for water managers to fine-tune storage and delivery operation
to reduce & eliminate detrimental effects of stream discharge
fluctuations."

O.K. Fry - Gunnison - Colo.
other life history - Bryan
- no R.R. reproduction
- Colo. R. Z. Powell & Glen Canyon -

Biotic — Fry — establish year class newly hatched
- p. 90 - Bjornn, T.C. Idaho Coop Fish River Unit modelling. of behavior - areas utilized - Chinook salmon
(most valuable fish sp. Col. R. basin - subject of enormous work IFIM) - w/ and w/o potential
pred. (young steelhead and brook trout) - completely dif. - i.e. if WUA - precisely secondary records
for same fish, same habitat, same flow, vastly different areas used & WUA.
concluded - "These results are illustrative of the need to include all factors that regulate abundance and habitat use in models such as the Instream Flow Incremental Methodology (IFIM) and Habitat Evaluation Procedures (HEP)."
- [Both use ~~habitat~~ suitability index curves for environmental factors -
theoretically biotic factors such as presence of steelhead and brook trout of certain size & density - but complexity
of situation in reality impractical to model - for ex.
if riffle vs. pool area - size of pool, changes in
pred-prey - interaction - (hab. use) at varying flows, turbidity,
times of year - enormously too complex. - as model a
Beethoven or Mozart concerto by totalling up quantity no. of do re mi's used
- would not approximate musical reality no matter how approx - but. real.

- Reiser. D.W. Summary of instream flow needs and issues in N. Am. - 1986 202 questionnaires, st. & fed agencies
50 states 16 Can. Prov. "Needs": development of new techniques
validation of existing methods - Most widely ~~used~~ applied method
is IFIM

– mind sets psycholo–
Last Rep. – re. problem – when agency designates "official" model a Utah Dept. Wildlife & IFIM – w/o – understanding limits (actually ... in belief that great prediction success) – ~~[illegible]~~ Current ~~stance~~ position of USFWS & proponents of IFIM (& HEP) – that is negotiation tool – "predicting changes biomass exceeds the current state of the ~~art~~" – and IFIM was not meant to simulate ecological interactions – but 1978 IFIM spokesperson clearly stated that "primary purpose for which IFIM developed ~~was~~ to predict changes biomass assoc. w/ species composition changes flow conditions!" – Thus over 10 yrs modeling against proponents and opponents – re. – scientific "controversy" – ~~what can~~ sets expectations for modeling – most of controversy problems – can be resolved if ~~we~~ it clearly defined what proponents & opponents argue over. clarify issues – comparing apple and orange, both fruit; one person loves orange, hates apple – can say equally loves fruit & hates fruit – until we clarify apples & oranges, then understand –

– Ex. Proponent & negotiation tool – not actual prediction " " – Bob Nehring.

Biotic–Abiotic
– Otter Cr.
– Fryin Pan
– $
red shiner
– Temp AZ
USFWS contract [illegible]
dollars [illegible]
factors most imp.
assoc. density & biomass
[illegible] habitat features AZ
N.M. [illegible]

Salk
Spray
onion

— If no good product - why spray - who uses. —
Geen - Utah

for Nov-Dec

↓

SRP - ex. Otter Crk.

— take before - after — depth, velocity, substr
— — — — temp, turbidity, - cover, etc - -

USFS shannon-weiner index
invert.
- ??
-
H - - - -

how much violence impede
try HSI on
suckers, chub, dace
BT RB -

- ~~fence~~ livestock - just trout?? - sprays for one

Chapman reps

Habitat
Biotic - Abiotic factors
- WUA - most are
- can put anything in PHABSIM

Bovee 1982
Inf Pap 12
IFIM not an ecosystem model

Monograph

Moore & Gregory 1988 TAFS 117(2): 162-170

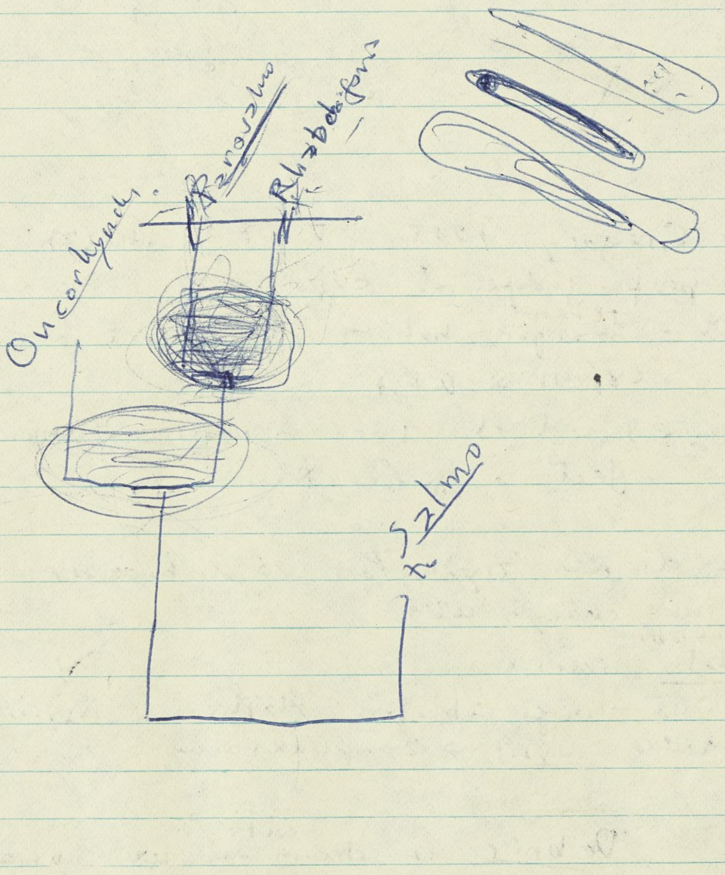
Prof. judgement w. WUA
- Ex. prof. judgement experts - - establishing year-cl - -
- trough - stream margin habit - cutthroat ~~nur~~
express as WUA -

interspecific effects
Reeves et al. 1988 - redside shiner & steelhead
temp effect on production

> Rieedi res. Flathead Pen 5 X biomass
no change WUA
ABIOTIC fact
physical - abi - habitat limiting
but biotic - no change abiotic - Flathead Mysis shrimp
- niches Mysis → zooplankton →

Debris in stream - no WUA change
cite
Abiotic "cover" substit in

Bottom line
it model seems simple
because cause-effect relations built in - but no model necessary


Oncorhynchus.
Parasalmo
Rhabdofario
Salmo

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NOV - DEC

re niche - niche ~~and~~ ~~omnis~~
wellside - steelhead
another Ches

Nancy Hoefs - IBI
Miller IBI Fisheries

Irvine, J. R. 1987 - Effects of varying flows in man-made streams on rainbow trout (S.g.) - -
+ Petts, Fontaine & Bartell, etc. see yellow pages enclosed

AFS economics symp.
40 yr 29 10-water fed. prog. - $2/day angler
Mon 1988 - $13
- Types econ. eval. - direct costs
- travel costs
confusion - CVM
- local, regional, st., nation

Desert Fishes Council

0032604
COLORADO STATE UNIVERSITY
DEPARTMENT OF FISHERY & WILDLIFE
ROBERT BEHNKE
FORT COLLINS CO 80523-0001

Ohmart, R.D., B. W. Anderson, and W.C. Hunter. 1988. The ecology of the lower Colorado River from Davis ~~Dam~~ Dam to the Mexico-United States international boundary: A community profile. USFWS Biol. Rep. 85 (7.19) 296 p. - ~~a~~ reviews synthesizes ecological info on ~~plants~~ vegetation and animal life (and fishes) changes associated w/ regulation & so a. - Refer to expert past-present info. + salt ~~cedar~~ rivers -

BIMONTHLY REPORT: FISHERIES-AQUATIC BIOLOGY
Nov.-Dec. 1988

I will continue to elaborate on my last bimonthly report on the basis for controversy regarding the predictive accuracy of ecological models and why governmental bureaucracies are so susceptible to the illusion of technique in their quest for "standard methods." Bureaucracies are goal-oriented organizations governed by rules, roles, and regulations to be carried out by a standard operating procedure. A standard method used by all government agencies to predict changes in species from changes in the environment is a highly desired goal. As such, conflicts are likely to arise between the simplistic application of an inadequate or inappropriate standard method and professional judgement based on evidence, knowledge, and experience reflected in reasoned thought.

As discussed in the last report, "verification" or "validation" of models such as IFIM rely on "bottleneck" situations, or negative evidence. For example, fish live in water, if all flow is shut off, fish will not exist (WUA = 0, fish biomass = 0, an excellent correlation). The obvious problem is that the excellent correlation of the negative state between fish and water, does not mean that the same correlation will exist between quantity of water (expressed in WUA habitat units) and quantity of fish. In the field of logic, this problem is known as the "necessary and sufficient" condition The necessary condition, typically can be readily defined and quantified, the "sufficient" condition (such as correlating habitat with fish biomass) can not. Thus, predictive success based on necessary conditions do not validate a model.

I have enclosed a copy of the FWS "Habitat Evaluation Notes" with an article discussing the use of habitat suitability index models to predict changes in abundance of four species of fish if riparian zone vegetated buffer strips were created. It would be interesting to have this project carried out so that the accuracy of these predictions could be tested. I am confident that they would bear little semblance to reality because of the logical problem of defining and quantifying "sufficient" conditions in biological systems.

I have, however, made some before and after comparisons from a comparable situation to illustrate the futility of attempting quantified, accurate predictions. About 1968, Nebraska Game and Parks Commission leased a strip of land along Otter Creek, a tributary to Lake McConaughy (Van Velson 1978). A livestock exclosure fence was constructed. After livestock were excluded, riparian vegetation grew vigorously and changed the stream environment similar to that hypothesized in the FWS model mentioned above. (lower temperature, reduced turbidity, reduced sediment load, increased cover, etc.). The fish species composition of Otter Creek during the 1957-1966 period (prelivestock exclosure was 1% rainbow trout, 17% brown trout, 22% white sucker, and 60% creek chub. In the 1974-76 period the change was: 97% rainbow trout, 2% brown trout and sucker and chub .5% each. I examined the FWS habitat suitability indices for these four species to obtain an indication of the predictive accuracy of change in species composition from changes in the various habitat components such as temperature, turbidity, cover, etc. Trends are apparent to the extent that "trout" habitat values would increase, but there is no way these habitat models could predict, with even moderate accuracy, the dramatic changes that resulted in the species composition in Otter Creek after riparian vegetation and stable stream banks modified the habitat, because of the problems of adequately defining the "sufficiencies" of these species, especially in interaction with each other.

The citation to Beattie et al. (1988) concerns biotic factor influences that can dramatically change fish species composition and abundance with no change in abiotic factors (physical habitat factors used in models). The introduction of a non-native predatory invertebrate (Mysis relicta) has dramatically changed the fish fauna of Flathead Lake. The angler catch of kokanee salmon declined from 327,162 in 1981 to 5,833 in 1987 due to Mysis competition for a common food supply. On the other side of the coin, the citation to Nehring (1988) relates that Mysis established in Ruedi Reservoir, Colorado, are sucked out of the reservoir through a hydro plant to provide an enormous new food supply to trout in the Frying Pan River below the sam. With no change in flow regime or habitat (WUA constant(, trout biomass has increased five fold from pre Mysis feeding.

Bill Warskow sent clipping from Apache Scout about trout production at the two hatcheries on the Reservation. I was told that plans are to replace the non-native rainbow trout with the native (and threatened) Apache trout for stocking all streams on the Reservation. I doubt that there is any ulterior motive for this decision, but a recreational fishery based on a native, threatened species, should result in higher instream flow values for those streams stocked with Apache trout.

ANNOTATED BIBLIOGRAPHY
NOV.-DEC. 1988

Arizona Wildlife News. Dec. 1988. Article mentions Ariz. Game and Fish Dept. sampling of Verde River from Perkinsville to Sycamore Canyon. Numerous specimens of the threatened spike dace (Meda fulgida) were found along with many squawfish and razorback suckers (stocked for restoration program by USFWS). Native species predominated. Only a relatively few specimens of non-native fishes (carp, catfish, smallmouth bass) were found.

Bain, M.B., J.T. Finn, and H.E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69(2):382-392. Two tributaries to the Connecticut River, one with a natural flow regime and one regulated by peak power production were studied and compared in relation to their fish communities. Fish species, small in size and preferring to live in shallow habitats, were absent from the fluctuating stream.

Beattie, W., P. Clancey, and R. Zubik. 1988. Effect of the operation of Kerr and Hungry Horre dams on the reproductive success of kokanee in the Flathead system. Final Rep. Bonneville Power Adm. 89p. The introduction of a non-native species of predatory crustacean (opossum shrimp, Mysis relicta) into Flathead Lake, Montana, has caused collapse of the kokanee salmon fishery in the lake and its tributaries by competition for a common food supply (water fleas, Daphnia). This is example where no change in abiotic (physical habitat) factors has occurred, but a change in biotic factors (addition of one new species of crustacean) has effected enormous changes in fish species composition, abundance, and biomass.

Flather, C.H. and T. W. Hoekstra. 1988 (draft). An analysis of the wildlife and fish situation in the United States, 1989-2040. U.S. Forest Service, draft report. The USFS is attempting to make 50 year predictions of fish and wildlife trends based on mathematical models. Each region of USFS has produced regional accounts (see following Citation) summarized for the whole country in this report. The report is a classic example of all of the problems I have continually pointed out in regards to predictive accuracy of any model to reflect trends of change in biological systems. The basic data base and evidence used to construct the models is so incomplete, inadequate, biased, and simply dumb, that any predictions made from it have little or no basis in fact and should not be taken seriously. Despite these limitations, very precise predictions are made. For example: "trout populations will decline from 173 to 47 per acre" (in 50 years)...."decline of 11.8%", etc. This false precision is an example of the "illusion of technique" as the precision is based on sophisticated and quantitative mathematical models without a critical evaluation of the information used to construct the models.

Flebbe, P.A., T. A. Hoekstra, and N.D. Cost. 1988. Recent historical and projected regional trends of trout in the Southeastern United States. U.S. Forest Service, Gen Tech. Rep. RM-160. This is one of the regional reports which the above citation used to make insane projections.

Heggens, J. 1988. Effect of experimentally increased intraspecific competition on sedentary adult brown trout (Salmo trutta) movement and stream habitat choice. Can. J. Fish. Aquat. Sci. 45(7):1163-1172. This paper demonstrates problems of defining "preferred" habitat if population observed is not completely "normal." To a section of stream with 19 natural resident adult trout, 130 additional trout were added. The "new" trout were forced to select less preferred sites (shallower areas with less cover). If such an "unnatural" density (which could occur, temporarily due to several natural causes) of trout were studied to record habitat suitability preferences (such as HSI curves), very erroneous data would result. The true habitat preference could only be obtained from the original 19 fish in the section, which maintained their preference by their advantage of size and prior residence.

Hendrickson, D.A. 1988. Conservation of desert pupfish, Cyprinodon macularius, in Mexico and Arizona. J. Ariz.-Nev. Acad. Sci. 23:15-16. Report on survey of potential reintroduction sites for this endangered species. Suggests future reintroductions should consider large rivers rather than small, isolated sites.

Hoefs, N. 1988(MS). Evaluation of the index of biotic integrity for use in resource inventory of the Current and Jacks Fork rivers, Ozark National Scenic Riverways, Missouri. Research plan for thesis research in regards to modifying IBI for site-specific utilization.

Irvine, J.R., I.G. Jowett, and D. Scott. 1987. A test of the instream flow incremental methodology for underyearling rainbow trout, Salmo gairdnerii, in experimental New Zealand streams. New Zeal. J. Man. Freshw. Res. 21:35-40. Another paper on problems in New Zealand for applying IFIM to predict changes in fish population associated with changes in flow. These authors found no correlation between weighted usable area (WUA) and abundance of rainbow trout. They conclude: "Fishery workers should not expect IFIM to predict impacts on fish populations from changes in flow regime; WUA is an estimate of the amount of suitable habitat, and many populations are not limited by physical habitat alone, but also by other factors such as food."

Miller, D.L. and 13 other authors. 1988. Regional applications of an index of biotic integrity for use in water resource management. Fisheries 13(5):12-20. Presents summary of use of IBI by several practitioners--their experience, results and suggested modifications. Emphasis is on understanding the need to adapt and modify IBI for specific conditions and geographical areas. Several state agencies and T.V.A. have adopted IBI as a standard monitoring method for water quality standards.

Nehring, R.B. 1988. Stream fisheries investigations. Colo. Div. Wildlf. Fed. Aid Proj. F-51-R. As mentioned in last report, Nehring is most vocal proponent of IFIM. In this report he states: "When properly applied by highly trained and skilled users, we believe IFIM is unequaled in its ability to quantify fish habitat units (WUA) as a function of discharge." I would have no argument with this statement concerning ability to "quantify", but the real problem concerns the lack of correlation between quantity of WUA and quantity (biomass) of fish. Nehring's own report documents these problems. In Frying Pan River, for a mile below Ruedi Reservoir, the trout have been exposed to a great new food supply of Mysis shrimp sucked out of reservoir through power plant. Without any change in flow or change in physical habitat (WUA values remained constant), the trout biomass has increased five fold, from less than 200 lb./acre (pre Mysis) to more than 900 lb./acre (post Mysis). From this Nehring concludes that it is not surprising that WUA does not relate to trout biomass in the Frying Pan River--which is obviously true, but is also clearly demonstrates an obvious factor (food) strongly influencing a fish population that is not considered in IFIM. Other examples without correlation between WUA and trout populations are explained by such influencing factors as siltation and metal toxicity that are not included in IFIM (that is, Nehring uses professional judgement to make IFIM "work" or fill in cracks in model). I would agree with Nehring's final comments that..."IFIM is not a panacea but a tool to be used judiciously.... Estimation of WUA values does not dispense with biological expertise, but provides an objective basis on which a biologist may apply his professional judgement." I would only add that an "objective basis" is not synonymous with a correct or valid basis.

Ohmart, R.D., B.W. Anderson, and W.C. Hunter. 1988. The ecology of the lower Colorado River from Davis Dam to the Mexico-United States International Boundary: A community profile. U.S. Fish and Wildlife Service Biol. Rep. 85(7.19):296p. Reviews historical changes in plant and animal life associated with dams and river regulations. Brief reference to Salt and Gila rivers.

Shrader, L.H. 1988. Use of the index of biotic integrity to evaluate the effects of habitat, flow, and water quality on fish communities in three western Great Plains streams. M.S. thesis, Colo. St. Univ.:120p. Example of IBI modifications to reflect local conditions. Additional components such as percent white suckers in species composition and percent non-native species were used to make IBI work more realistically to reflect habitat and water quality conditions of the region.

Simons, L.H. 1988. Conservation of the Gila topminnow: saving diversity at multiple levels. J. Ariz.-Nev. Acad. Sci. 23:16. The endangered topminnow (Poecilliopsis occidentalis) has been established in 38 new sites in Arizona, but 36 of the 38 new populations are derived from a single parental source. Recommendation is to diversify parental sources for future introductions to preserve intraspecific diversity and then downlist from endangered to threatened.

U.S. Fish and Wildlife Service. Fish and Wildlife News, Aug.-Oct. 1988. Discusses five year reauthorization of Endangered Species Act. Changes and additions to Act call for monitoring of candidate species, increased protection for listed plant species, increased public input into recovery plans, and species by species cost analysis of recovery programs.

U.S.F.W.S. Instream Flow and Wetland Memorandum (Nov. 1988). Mentions new FERC regulations to implement provisions of NEPA (previously, FERC claimed exemption from NEPA).

U.S.F.W.S. Habitat Evaluation Notes (Nov. 1988). On page 2 of this issue, is example of use of habitat suitability index to predict changes in abundance of four fish species if riparian buffer strips are created on streams. How far removed from reality these predictions are likely to be is discussed in my report using example of Otter Crk., Neb. (copy of this publication enclosed).

Van Velson, R.C. 1978. The McConaughy rainbow-life history and a management plan for the North Platte River Valley. Neb. Game and Parks Comm. Tech. Ser. 2. This reference relates to the Otter Creek story in report.