FINAL APPRAISAL REPORT

RED RIVER VALLEY

MUNICIPAL, RURAL, AND INDUSTRIAL

WATER NEEDS ASSESSMENT

PHASE I, PART B

INSTREAM FLOW NEEDS ASSESSMENT

Aquatic Life Maintenance Flow Needs Assessment
Riverine Riparian Corridor Maintenance Needs Assessment
Water Quality Improvement Opportunities and Needs Assessment
Flow-Related Recreational Opportunities and Needs Assessment
Recreational Economics Assessment
Legal and Institutional Analysis of State Water Law

SHEYENNE RIVER AND RED RIVER OF THE NORTH

NORTH DAKOTA and MINNESOTA

AUGUST 1999

OVERVIEW

The Bureau of Reclamation (Reclamation) released the first component of the Red River Valley Municipal, Rural, and Industrial (MR&I) Water Needs Assessment, Phase I, Part A, in April 1998 (Bureau of Reclamation April 1998). During review of drafts of the Phase I, Part A report, the North Dakota Congressional Delegation and others expressed concern that it did not address instream flow issues related to aquatic life and water quality, and thus underestimated the total water need. In response to these concerns, and at the request of the North Dakota Congressional Delegation, Reclamation agreed to conduct an instream flow needs assessment for the Sheyenne River and portions of the Red River of the North. This report constitutes Phase I, Part B, of the Red River Valley MR&I Water Needs Assessment. This document has been prepared for planning purposes only (appraisal level analysis) and does not constitute a commitment of resources to implement the recommendations herein.

The purposes of the assessment were to:

1. Quantify the relationship between seasonal flows and available habitat for selected fish species.
2. Provide a seasonal instream flow regime for aquatic life and riverine riparian corridor maintenance which was developed from the quantification between seasonal flows and available habitat.
3. Identify water quality improvement opportunities and needs.
4. Identify flow-related recreational opportunities and needs.
5. Identify changes in recreational activities that would result from the seasonal instream flow regime (changes in use, Regional economic impacts, and economic benefits).
6. Identify legal and institutional instream flow-related opportunities and needs associated with State water law for North Dakota and Minnesota.

The study area for the Instream Flow Needs Assessment was defined as the Sheyenne River from the Harvey, North Dakota, U.S. Geological Survey (USGS) gaging station to the confluence with the Red River of the North just downstream of Fargo, North Dakota. Also included in the study area was the Red River of the North from upstream of Fargo, North Dakota, near Wahpeton, North Dakota, and downstream to the Emerson, Manitoba, Canada, International gaging station. The primary Red River of the North river reach of interest was the reach from Fargo, North Dakota, to the confluence with the Buffalo River (Halstad, Minnesota USGS gaging station)(Figure 1).

Aquatic Life Maintenance Flow Needs Assessment

To quantify the relationship between available fishery habitat and flow, the Modified Habitat Preference Methodology (Modified Physical Habitat Simulation Method) of the Instream Flow Incremental Methodology (IFIM)(Stalnaker et al. 1994) and a variation of the computational methods used by the Physical Habitat Simulation System (PHABSIM) of the IFIM were used.

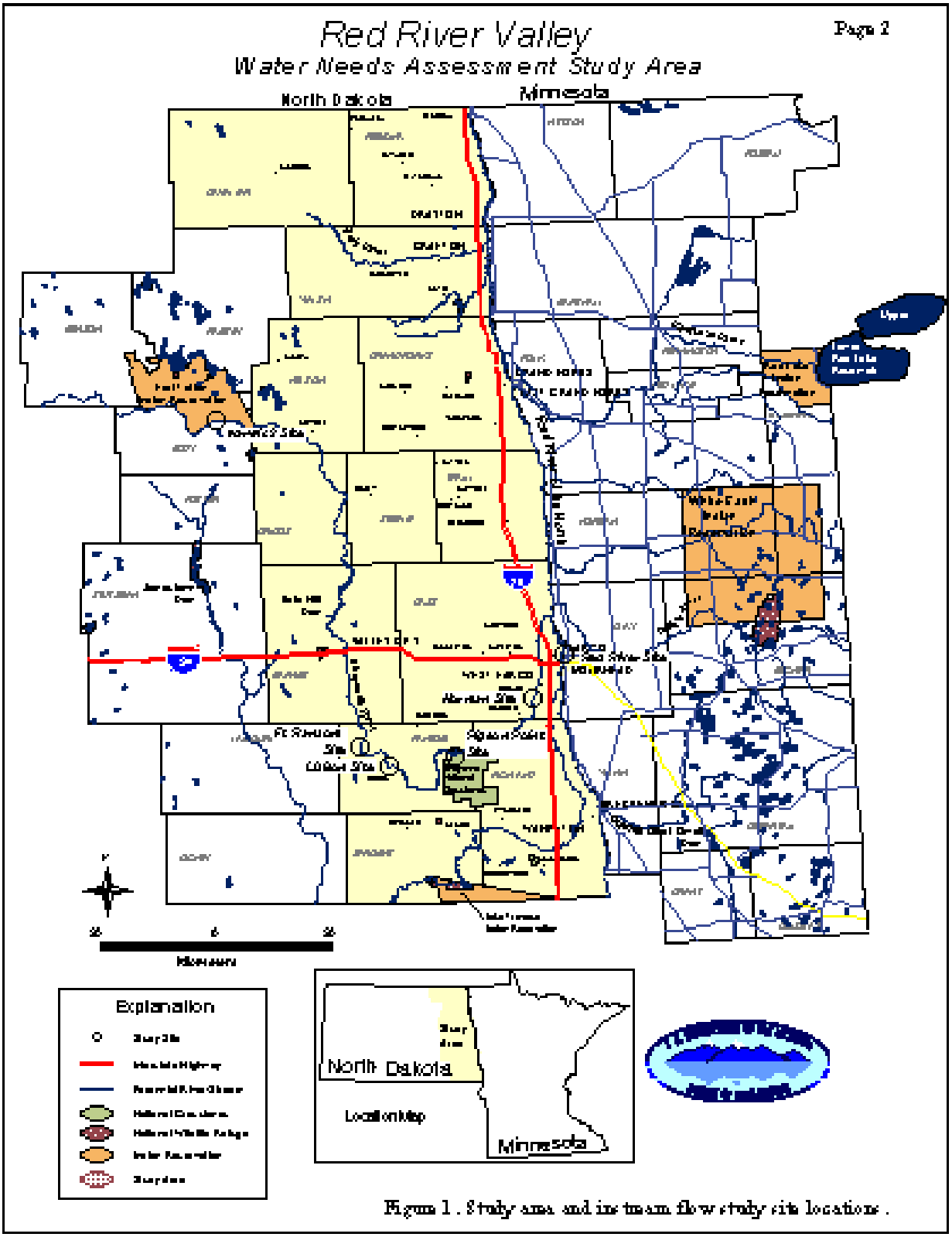

Figure 1. Study area and instream flow study site locations.

The quantitative relationships developed between available fishery habitat and seasonal instream flows are displayed in Figures 2 through 5 for Reclamation's six study sites. These relationships will be used to evaluate the alternatives to be addressed in Phase II of the Red River Valley MR&I Water Needs Assessment.

Multiple methods were used to evaluate instream flow needs for aquatic life and riverine riparian corridor maintenance, and water quality improvement opportunities and needs. The seasonal instream flow regime for maintenance of the aquatic community was derived utilizing the following comparative methods: (1) Hydrologic Methods: (a) Annual mean flow comparison, (b) Average (mean) flow for all water years - HIGH (Spawning)/LOW (Maintenance) period comparison, (c) Tennant Method comparison (Tennant 1976), (d) 25% of the annual mean flow comparison, and (e) Water year type flow comparison for DRY-AVERAGE-WET years for HIGH (Spawning)/LOW (Maintenance) period flows; (2) Wetted Perimeter vs. Flow Method comparison (O'Shea 1995); (3) Hydraulic Rating Method employing the wetted perimeter technique (Nelson 1980); and, (4) Modified Habitat Preference Methodology (Modified Physical Habitat Simulation Method) of the Instream Flow Incremental Methodology (IFIM)(Stalnaker et al. 1994) and a variation of the computational methods used by Physical Habitat Simulation System (PHABSIM) of the IFIM. A Goal Oriented Methodology was also used in developing the aquatic life maintenance seasonal instream flow regime. The Goal Oriented Methodology was explored to help derive the seasonal instream flow regime as well as to provide an example for resource managers to consider in utilizing the seasonal instream flow regime for management and planning purposes. The seasonal instream flow regime developed for aquatic life maintenance is displayed in Table 1.

It should be noted that the seasonal instream flow regime was not considered an additional demand to be satisfied in Phase II of the Red River Valley MR&I Water Needs Assessment. The seasonal instream flow regime is provided only for consideration as a means to protect the basic needs of aquatic life in the river systems and is not intended to be minimizing or optimizing. The seasonal instream flow regime is provided for consideration by decisionmakers and resource managers for future management and planning purposes. Seasonal instream flow needs can be defined many ways. For this Instream Flow Needs Assessment, these flows were defined as those which would maintain the ecological integrity of the riverine ecosystem (maintaining the existing community structure at a defined level based on the application of hydrologic, hydraulic, and habitat based methodologies).

The analysis demonstrated that the application of different methodologies do result in differing recommendations for any given location on the Sheyenne River and/or the Red River of the North. Use of the Modified Habitat Preference Method, both the multiplicative technique and the Goal Oriented Methodology (plus consideration of historic flows and hydrologic and hydraulic method results) resulted in the most defensible approach to establishing a seasonal instream flow regime for aquatic life maintenance for the study area for this appraisal level of analysis.

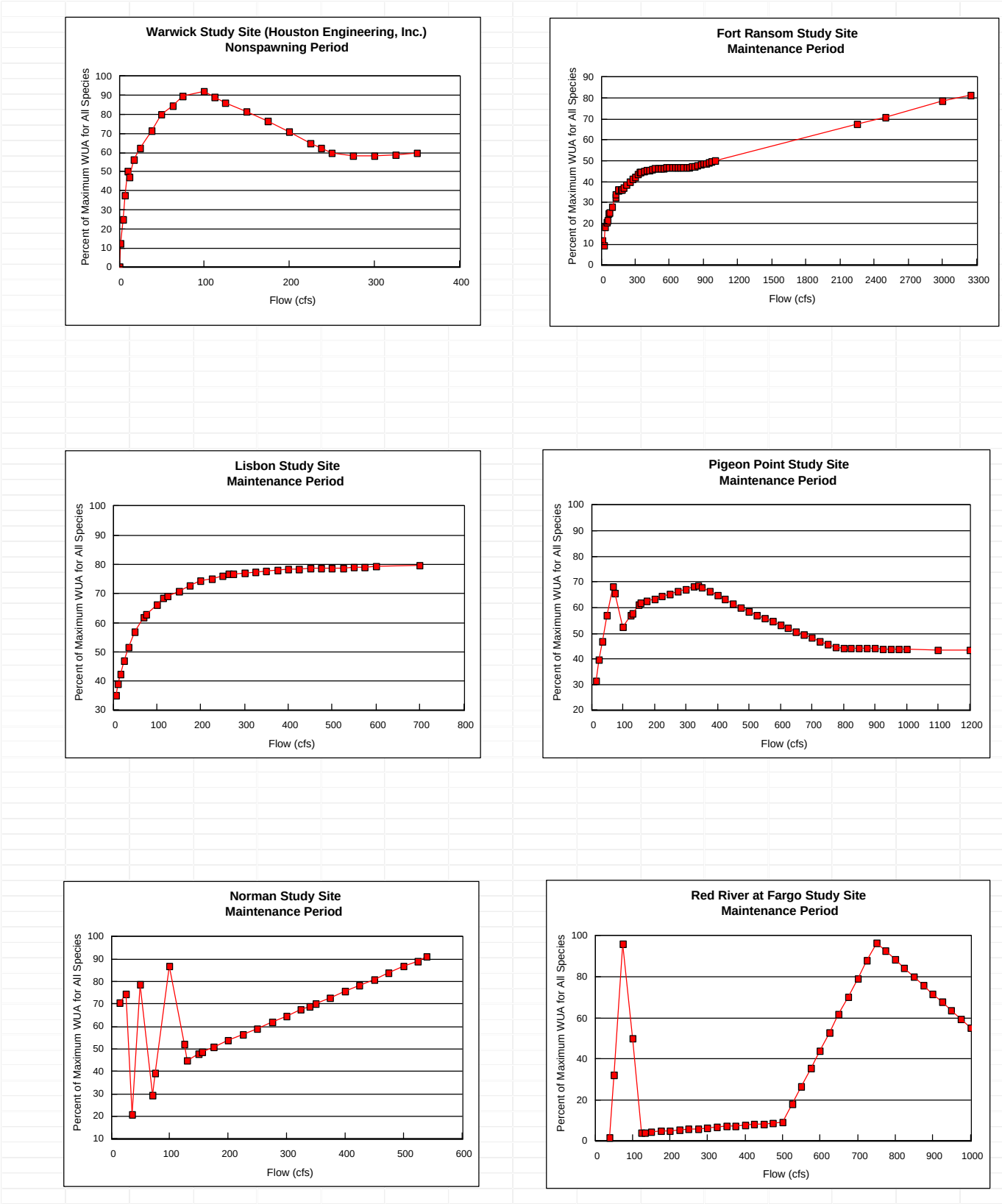

Figure 2. Percent of maximum weighted usable area available for all species of fish during the maintenance period (July-February) versus flow at Reclamation's six study sites.

Figure 3. Percent of maximum weighted usable area available for all species of fish during the spawning period (March-June) versus flow at Reclamation's six study sites.

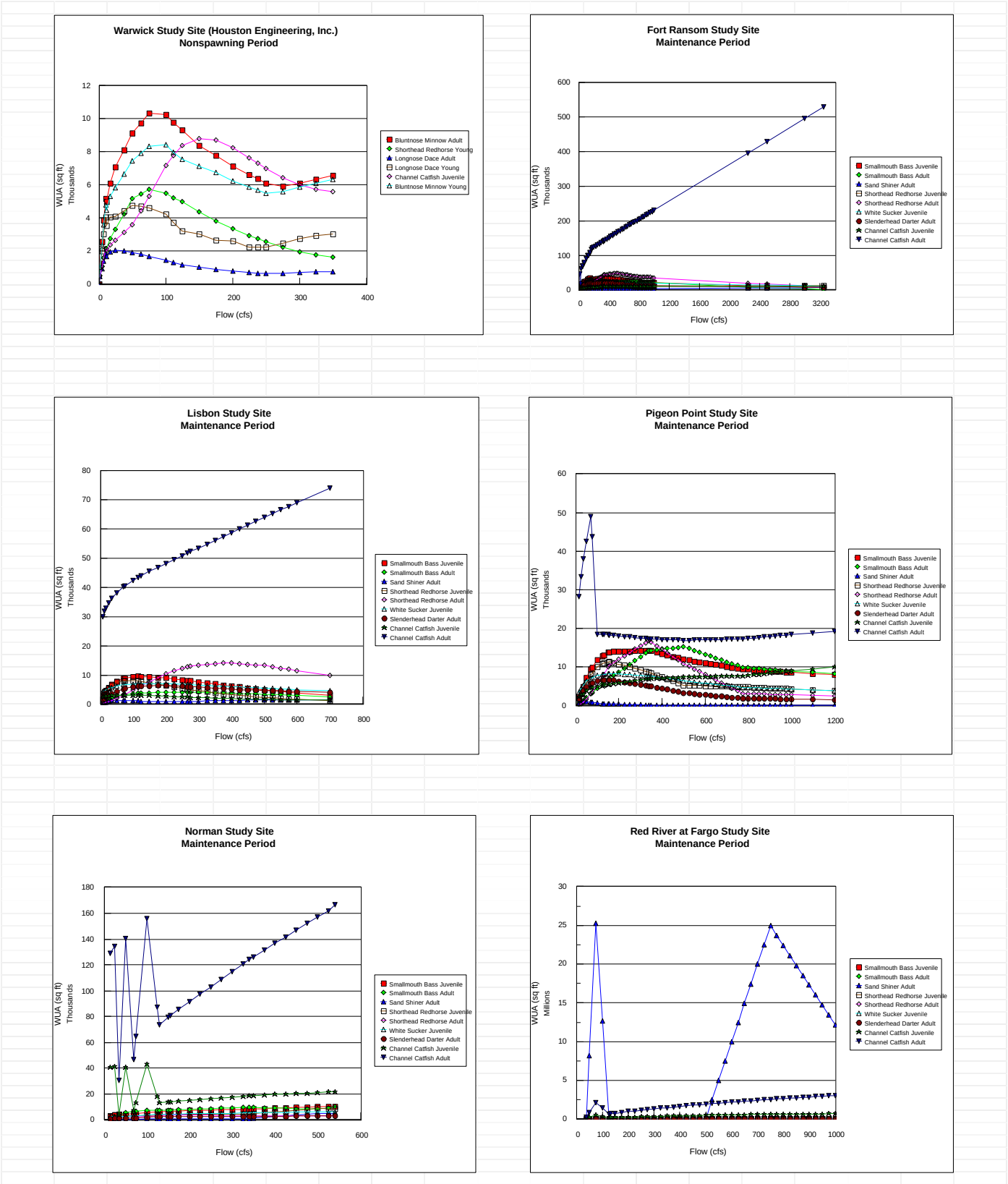

Figure 4. Weighted usable area (sq. ft. per study reach) by species of fish during the maintenance period (July-February) versus flow at Reclamation's six study sites.

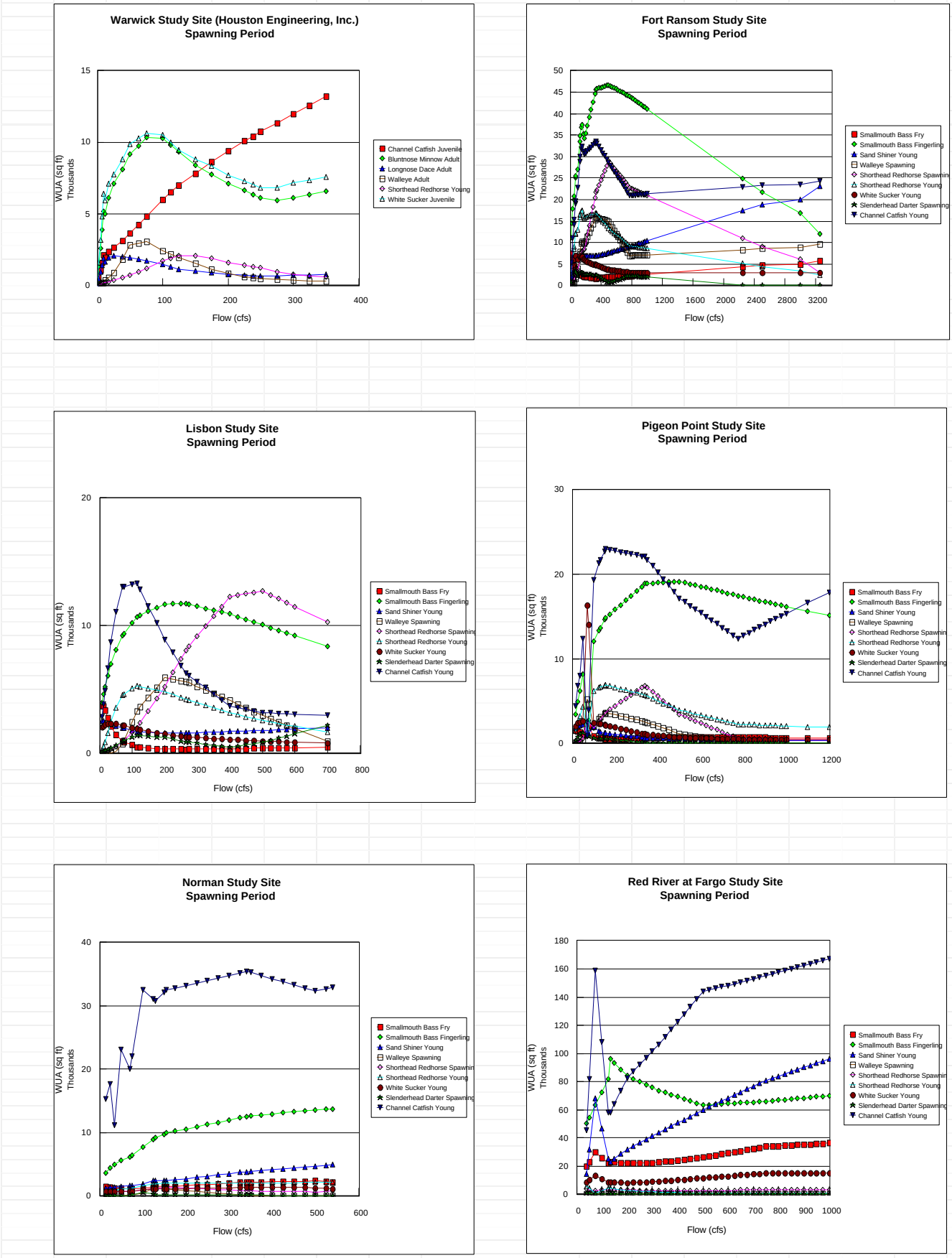

Figure 5. Weighted usable area (sq. ft. per study reach) by species of fish during the spawning period (March-June) versus flow at Reclamation's six study sites.

Table 1
Sheyenne River and Red River of the North
Seasonal Instream Flow Regime for Aquatic Life and Riverine Riparian Corridor Maintenance and Water Quality Improvement

Location	Flows in Cubic Feet Per Second (cfs)												
	Jan[1]	Feb	Mar[1]	Apr	May[2]	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WQI[3]
Sheyenne River													
Harvey, ND	15	15	25	25	25	25	15	15	15	15	15	15	16
Warwick, ND[4]	25	25	100	100	100	100	25	25	25	25	25	25	89
Cooperstown, ND	50	50	125	125	125	125	50	50	50	50	50	50	18
Baldhill Dam, ND	50	50	125	125	125	125	50	50	50	50	50	50	[-]
Valley City, ND	50	50	125	125	125	125	50	50	50	50	50	50	50
Lisbon, ND[4]	70	70	225	225	225	225	70	70	70	70	70	70	41
Kindred, ND[4]	50	50	155	155	155	155	50	50	50	50	50	50	81
West Fargo, ND[4]	50	50	100	100	100	100	50	50	50	50	50	50	[-]
Harwood, ND	50	50	100	100	100	100	50	50	50	50	50	50	64
Red River of the North													
Wahpeton, ND	100	100	450	450	450	450	100	100	100	100	100	100	[-]
Hickson, ND	100	100	450	450	450	450	100	100	100	100	100	100	450
Fargo, ND[4]	100	100	450	450	450	450	100	100	100	100	100	100	336[3]
Halstad, MN	200	200	1125	1125	1125	1125	200	200	200	200	200	200	723
Grand Forks, ND	440	440	2160	2160	2160	2160	440	440	440	440	440	440	533
Drayton, ND	480	480	2610	2610	2610	2610	480	480	480	480	480	480	NC
Emerson, Manitoba, Canada	520	520	3060	3060	3060	3060	520	520	520	520	520	520	NC

[1]Maintenance flows provided for the months of July-February; Spawning flows provided for the months of March-June.

[2]Riparian corridor maintenance flows would be met by the aquatic life maintenance flows and the natural riverine flow regime. Incorporating riparian corridor maintenance flow **improvement** recommendations would require overbank flows be allowed on an annual or semi-annual basis along both rivers. It is recommended that flows in excess of channel capacities be provided between late May and early July to assist in pioneering species germination and growth. Flows which are out of channel (nondamaging channel capacity) should occur for a 2-week period and precede cottonwood and willow seed disbursal by approximately 1 week. This flow scheme should produce adequate moist soil conditions to benefit seed germination and growth.

[3]WQI = maximum flows needed for water quality improvement (the existing streamflow plus the additional flow needed to meet the water quality standard; D.O. used when it was the only flow estimate available) for each station for all months throughout the year. A WQI value of [-] indicates that no water quality standards were exceeded for the period of analysis with the existing streamflow regime. NC=no water quality flow calculation made. Aquatic life maintenance flows which are lower than the water quality flows could result in exceedences of specific water quality standards, depending on the seasonality factor. WQI value for reach below Fargo, based on North Dakota Department of Health data.

[4]Actual data collection resulted in flow regime (either Reclamation or Houston Engineering, Inc. sites; all other site flow regimes based on estimated needs).

For both the Sheyenne River and the Red River of the North, the seasonal instream flow regime for aquatic life maintenance would generally result in similar amounts of habitat being maintained for all sites considered (mean historic flows versus seasonal instream flow regime), but require less water to produce these results.

The seasonal instream flow regime would maintain, for the Sheyenne River, an average of 61 percent of the maximum WUA for all species during the maintenance period of the year and 66 percent of the maximum WUA for all species during the spawning period of the year. The seasonal instream flow regime would maintain, for the Red River of the North, an average of 50 percent of the maximum WUA for all species during the maintenance period of the year and 70 percent of the maximum WUA for all species during the spawning period of the year.

On the Platte River in Nebraska, the U.S. Fish and Wildlife Service developed a flow regime for fisheries which provided approximately 72 percent of the optimum physical habitat for all groups of fish analyzed [Biological Opinion for Kingsley Dam (FERC Project No. 1417) and North Platte/Keystone Diversion Dam (FERC Project No. 1835) Projects, Nebraska]. The seasonal instream flow regime for aquatic life maintenance flows compares favorably with the Platte River study (Sheyenne River - maintaining an average of 61 percent of the maximum WUA available for all species during the maintenance period of the year and 66 percent of the maximum WUA available for all species for the spawning period of the year; Red River of the North - maintaining an average of 70 percent of the maximum WUA available for all species during the maintenance period of the year and 70 percent of the maximum WUA available for all species for the spawning period of the year).

Appendices A-F contain Aquatic Life Maintenance Flow Needs Assessment related material.

Riverine Riparian Corridor Maintenance Needs Assessment

The seasonal instream flow regime for maintaining the Sheyenne River riparian corridor and the Red River of the North riparian corridor was developed by first evaluating the relationships between streamflow and riparian water table elevations along these rivers. The relationships between existing streamflow and riparian water table elevations along both rivers were evaluated using methodology developed for the San Pedro River, Arizona, study (Jackson et al. 1987). Secondly, the seasonal instream flow regime for aquatic life maintenance was reviewed and items were added which would maintain the existing long-term river-specific riparian corridors (see Table 1). Conditions required to maintain and improve the existing flood plain forest community are identified. Appendix G contains the Riverine Riparian Corridor Maintenance Needs Assessment.

Water Quality Improvement Opportunities and Needs Assessment

The water quality improvement opportunities and needs assessment evaluated historic streamflow data against stream-specific water quality standards and analyzed the relationships between water

quality and flow. For pollutants that exceeded the water quality standards over a large range of flow, it was recommended that control or reduction be achieved through in-basin measures. These pollutants were phosphorus, nitrate, ammonia and fecal coliform. Phosphorus and nitrate reduction could be reduced through best management practice applications for the nonpoint source portion and through more restrictive Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) permit effluent limitations for the point sources. Sources of ammonia were generally treated effluent discharges or the conversion of nitrate to ammonia under reducing conditions. Ammonia can be controlled best at the source in a treatment plant. Dissolved oxygen (D.O.) improvement would be most effectively controlled by controlling biological oxygen demand (BOD) loadings, although low D.O. appears to be also affected by environmental conditions, i.e., icing. Fecal coliform data were limited, but it appears that the source is urban storm runoff. The data and standards exceedences evaluated covered a large range of flow rates and, to improve conditions, would need to be controlled by application of best management practices to urban storm runoff.

Other water quality parameters that had exceedences at low flow rates such as boron, chloride, and percent sodium may be affected by deliveries of water with lower concentrations to the Sheyenne and Red rivers (import of water). The instream flow needs for water quality were estimated by using a mixing equation. The equation was used to calculate the additional flow needed to meet the water quality standard (see Table 1). Appendix H contains the Water Quality Improvement Opportunity and Needs Assessment.

Flow-Related Recreational Opportunities and Needs Assessment and the Recreational Economics Assessment

Recreational usage associated with the aquatic environment and the Sheyenne and Red River of the North river corridors are analyzed by comparing river recreational potential associated with the developed seasonal instream flow regime for aquatic life and riverine riparian corridor maintenance and those flows that currently exist. Recreational opportunities and needs are examined and recommendations provided. The recreational economics assessment addresses changes in recreational activities due to recommended changes in instream flows: changes in use, Regional economic impacts, and economic benefits). Appendices I-J contain the Flow-Related Recreational Opportunities and Needs Assessment and Recreational Economics Assessments.

Legal and Institutional Analysis of State Water Law

A legal and institutional analysis of State Water Law was conducted, and potential means to protect environmental instream flows are discussed for the Sheyenne River and the Red River of the North, North Dakota and Minnesota. The primary focus of the legal and institutional analysis is on North Dakota Water Law. This analysis can be considered to be an update to Nelson et al. (1978). In Nelson et al. (1978), the U.S. Fish and Wildlife Service's Biological Services Program identified and evaluated the most promising institutional methods for reserving instream flows to benefit fish and wildlife in North Dakota. Information developed in this analysis is included in Appendix K.