PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Community Ecology And Food Web Studies In The Columbia River Basin

BPA project number: 20031
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Olympia Forest Sciences Laboratory, Pacific Northwest Research Station, United States Forest Service

Business acronym (if appropriate) USFS

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
2.1A, 2.2.A, 4.1A, 4.1D, 5.5A, 5.7A, 7.0A, 7.1A, 7.1D, 7.1E, 7.1F, 7.1G, 7.1I, 7.6A, 7.6B, 7.6C, 7.6D, 7.8A, 7.8B, 7.8D, 7.8I, 7.8J, 10.2C, 10.4A, 10.5A, 10.7A, 11.2C, 11.2D

FWS/NMFS Biological Opinion Number(s) which this project addresses

Other planning document references

Short description
The most abundant species of plant and animal in the water bodies within the watershed, their positions in the food web, and their contributions to the biotic community as a whole will be identified to elucidate their roles as food for fish and wildlife.

Target species

All identifiable species from the water bodies will be listed, and their impact on the food webs supporting the resident and migratory fish and wildlife species that depend on the aquatic community for nutrition will be estimated.

Section 2. Sorting and evaluation

Subbasin
Chelan and Crab or Entiat

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☒ Resident fish ☒ Wildlife	☒ Multi-year (milestone-based evaluation) ☒ Watershed project evaluation	☒ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☒ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9506402	Upper Yakima Species Interactions Study	This will provide a basis of comparison with the situation in neighboring tributaries
9152	Feasibility of Sockeye Salmon Reintroduction to Wallowa and Warm Lakes	The food web will indicate the food resources needed by these fishes.
9111	Evaluate Effects of Food Web	The study in Lake Chelan and

	Changes on Native Fish Restoration Strategies	adjacent water courses will provide a list of species actually involved in the local food webs and provide a basis of comparison.
9081	Impact of Exotic Fishes and Macrophytes on Salmonids in Littoral Areas	The food web models will provide a means to evaluate changes caused by introducing exotic species

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Obtain physical and chemical background information	a	On-site sampling and analysis with sampling to meet other objectives
		b	Determination of water quality variables, including temperature, flow rate, electrical conductivity, turbulence, pH, hardness, COD, and the concentrations of oxygen, chloride, iron, free phosphate, calcium, ammonium, nitrite, nitrate, and other ions.
2	Determine structure of the biotic community	a	Collect, preserve, and identify to species the important microorganisms and invertebrates in natural lentic (Lake Chelan) and lotic habitats. Sampling should be completed at least twice during each season for two years..
3	Model food web construction	a	Using methods described by Heckman and Hardoim (1995), a computerized food web will be constructed. This can be used to predict changes affecting the fish and

			wildlife populations expected from impacts on the microorganisms and invertebrates.
4	Baseline for biomonitoring	a	.The results obtained in near pristine habitats will provide evaluations of species that may by indicators of certain kinds of habitat. These can be used for future biomonitoring.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	9/2001	Selection of sites, compiling physical and chemical data, collecting specimens	End of field work	80.00%
2	10/1999	10/2002	Identification, preserving, and photographing specimens		15.00%
3	10/2001	10/2003	Establishment of computerized food web for prognoses on fish and wildlife effects		5.00%
4	10/1999	9/2003	Identification of habitat indicators		0.00%
				Total	100.00%

Schedule constraints
Sampling must include at least two visits to the sites per season

Completion date
10/2003, with first results available 10/2001

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	For one man-year (two helpers for	%45	30,000

	up to six months each)		
Fringe benefits	Estimated	%7	5,000
Supplies, materials, non-expendable property	Chemicals, test kits, collection equipment, laboratory equipment, and film.	%12	8,000
Operations & maintenance			0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Microscope and electronic equipment	%27	18,000
NEPA costs			0
Construction-related support			0
PIT tags	# of tags:		0
Travel		%6	4,500
Indirect costs			0
Subcontractor			0
Other			0
TOTAL BPA FY2000 BUDGET REQUEST			$65,500

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Total project cost (including BPA portion)			$65,500

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$65,500	$10,000	$45,000	$ 0

Section 6. References

Watershed?	Reference
☐	Caspers, H., and C. W. Heckman. 1981. Ecology of orchard drainage ditches along the freshwater section of the Elbe Estuary. Biotic succession and the influence of changing agricultural methods. Arch. Hydrobiol./Suppl. 43:347-486.
☐	Caspers, H., and C. W. Heckman. 1982. The biota of a small standing water

	ecosystem in the Elbe flood plain. Arch. Hydrobiol./Suppl. 61:227-316.
☒	De-Lamonica-Freire, E., and C. W. Heckman. 1996. The seasonal succession of biotic communities in wetlands of the tropical wet-and-dry climatic zone. III. The algal communities in the Pantanal of Mato Grosso, Brazil. Int. Rev. ges. Hydrobiol. 81:255-282.
☒	Hardoim, E. L., and C. W. Heckman. 1996. The seasonal succession of biotic communities in wetlands of the tropical wet-and-dry climatic zone. IV. The protozoan communities in the Pantanal of Mato Grosso, Brazil. Int. Rev. ges. Hydrobiol. 81:367-384.
☒	Heckman, C. W. 1979. Rice Field Ecology in Northeast Thailand. Monographiae Biologicae, Vol. 34. Dr. W. Junk, The Hague. 228 pp.
☒	Heckman, C. W. 1981. Long-term effects of intensive pesticide applications on the biotic community in orchard drainage ditches near Hamburg. Arch. Environ. Contam. Toxicol. 10:392-418.
☐	Heckman, C. W. 1982a. Ecophysiological and phylogenetic characterization of a wintertime biotic community in shallow water habitats near Hamburg. Int. Revue ges. Hydrobiol. 67:361-386.
☐	Heckman, C. W. 1982b. Pesticide applications on aquatic habitats. Environ. Sci. Technol. 16:48A-57A.
☒	Heckman, C. W. 1983. The recovery of the biotic community in a lotic freshwater habitat after extensive destruction by chlorine. Int. Revue ges. Hydrobiol. 68:207-226.
☒	Heckman, C. W. 1984a. Effects of dike construction on the wetland ecosystem along the freshwater section of the Elbe Estuary. Arch. Hydrobiol./Suppl. 61:397-508.
☐	Heckman, C. W. 1984b. The ecological importance of wetlands along streams and rivers and the consequences of their elimination. J. Ecol. Environ. Sci. 10:11-29.
☒	Heckman, C. W. 1986a. Tidal influence on the wetland community structure behind the dike along the Elbe Estuary. Arch. Hydrobiol./Suppl. 75:1-117.
☒	Heckman, C. W. 1986b. The role of marsh plants in the transport of nutrients as shown by a quantitative model for the freshwater section of the Elbe Estuary. Aquatic Botany 25:139-151.
☐	Heckman, C. W. 1989. The use of electronics in mapping the distribution and abundance of flora and fauna. In: Proc. Regional Seminar on Methods of

	Biological Inventory and Cartography in Ecosystem Management (BICEM), Tokyo. UNESCO/MAB. pp. 140-161.
☒	Heckman, C. W. 1990. The fate of aquatic and wetland habitats in an industrially contaminated section of the Elbe floodplain in Hamburg. Arch. Hydrobiol./Suppl. 75:133-245.
☐	Heckman, C. W. 1992. Die Tierwelt des Bodens und der Watten in der Tide-Elbe. In: H. Kausch (Ed.), Die Unterelbe. Zentrum fuer Meeres- und Klimaforchung, Bericht No. 19, Hamburg. pp. 191-203.
☒	Heckman, C. W. 1994. The seasonal succession of biotic communities in wetlands of the tropical wet-and-dry climatic zone. I. Physical and chemical causes and biological effects in the Pantanal of Mato Grosso, Brazil. Int. Rev. ges. Hydrobiol. 79:569-589.
☐	Heckman, C. W. 1995. The chemistry of headwater streams in the Rio das Mortes System and its effect on the structure of the biotic community. In: P. Seidl et al. (Eds.), Chemistry of the Amazon. Amer. Chem. Soc., Washington. pp. 248-264.
☒	Heckman, C. W. 1997. Description of a dynamic ecotone in the Pantanal of Mato Grosso, Brazil. Ecotropica 3:1-7.
☒	Heckman, C. W. 1998a. The seasonal succession of biotic communities in wetlands of the tropical wet-and-dry climatic zone. V. Climatological influences on life cycles of invertebrates in the Pantanal of Mato Grosso. Int. Rev. ges. Hydrobiol. 83:31-63.
☒	Heckman, C. W. 1998b. The Pantanal of Pocone Int. Monographiae Biologicae, Vol. 77. Kluwer Academic Publishers, Dordrecht. 622 pp.
☐	Heckman, C. W., J. L. E. Campos, and E. L. Hardoim. 1997. Nitrite concentration in well water from Pocone, Mato Grosso, and its relationship to public health in rural Brazil. Bull. Environ. Contam. Toxicol. 58:8-15.
☐	Heckman, C. W., and E. L. Hardoim. 1995. Uso da informatica no ensino de ciencias, educacao e meio ambiente. Rev. Educ. Publica, Cuiaba 4:140-149.
☒	Heckman, C. W., E. L. Hardoim, S. A. Ferreira, and A. Kretzschmar. 1993. Preliminary observations on some cosmopolitan alga species in ephemeral water bodies on the Pantanal. In: B. Gopal et al. (Eds.), Wetlands and Ecotones. pp. 279-292.
☐	Heckman, C. W., H. Kameith, and M. Stoehr. 1990. The.usefulness of various

	numerical methods for assessing the conditions in water bodies. Int. Rev. ges. Hydrobiol. 75:353-378.
☒	Heckman, C. W., and H. Kausch. 1996. Veraenderungen und Gefaehrdungen der Flussmarschen. In: J. Lozan and H. Kausch (Eds.), Warnsignale aus den Fluessen. Blackwell, Berlin. pp. 280-286.
☐	Heckman, C. W., and R. Schade (1989). Biotische Verhaeltnisse im Harburger Binnenhafen. In: Umweltbehoerde Hamburg (Ed.),
☒	Heckman, C. W., B. R. S. Trindade, and E. L. Hardoim. 1996. Environmental conditions in the Pantanal of Mato Grosso conducive to natural eublenophyte populations. Japan. J. Limnol. 58:21-34.
☒	Junqueira, M. V., and C. W. Heckman. 1998. Multifactorial assessment of physical modifications, impoundment, and contamination of a stream passing through an oil refinery in Minas Gerais, Brazil. Limnologica 28:329-345.
☒	Kretzschmar, A. U., and C. W. Heckman. 1995. Estrategias de sobrevivencia das especies de Ampulariidae durante mudancas das condicoes ambientais extremas do ciclo sazonal sob o clima tropical umido-e-seco. - Acta Limnol. Brasileira 7:60-66
☒	Kretzschmar, A., S. A. Ferreira, E. L. Hardoim, and C. W. Heckman. 1993. Activity peak of the Asplanchna sieboldi rotifer aggregation and its relationship to the seasonal wet-and-dry cycle. In:B. Gopal et al. (Eds.), Wetlands and Ecotones. pp. 293-301.
☒	Prado, A. L. de, C. W. Heckman, and F. R. Martins. 1994. The seasonal succession of biotic communities in wetlands of the tropical wet-and-dry climatic zone. II. Aquatic macrophytes in the Pantanal of Mato Grosso. Int. Rev. ges. Hydrobiol. 79:397-421.

PART II - NARRATIVE

Section 7. Abstract

The research will yield a synopsis of the synecology of the main water bodies in the watershed. The results will include a summary of physical and chemical conditions in the water during each season, a description of the watersheds and riparian zones, lists to outline the structures of the biotic communities encountered, and a tentative food web model to reveal the trophic relationships within and among the communities. The sites investigated will be visited several times during each season to analyze the physical and

chemical variables and collect samples of identifiable stages of the microorganisms and macroscopic invertebrates. Information on the macrophyte vegetation and vertebrate fauna will be obtained from on-site observations supported by supplemental information from the literature. In most cases, the organisms will be identified to species, and the role of each in the food web will be incorporated in a computer model. The study will provide a means of evaluating the importance of individual species for the functioning of the biotic community and a way of estimating the effects of local extinction of each plant and invertebrate species on the fish and wildlife. Sampling sites will be selected to permit the greatest variety of habitats in a closed section of the river system to be surveyed in detail. Physical and chemical features will be determined in the field by standard methods , as described by (Heckman, 1990,1994, 1995, 1998a). Species will be identified using appropriate literature as described by Caspers and Heckman (1981, 1982), Heckman (1984a, 1986a, 1990, 1998a, b), and Hardoim and Heckman (1996). The food web model will be subject to correction and enlargement as additional information becomes available. To confirm suspected trophic relationships, individual species will be observed in the laboratory or at local fish hatcheries.

Section 8. Project description

a. Technical and/or scientific background

The middle section of the Columbia River System includes the large, natural Lake Chelan and neighboring lotic tributaries. Because damming results in the conversion of natural lotic to artificial lentic habitats, the regional biota of natural lentic habitats along the river system should be determined as a baseline for monitoring the development of the biotic community in new impoundments, in which profound changes in the community structure occur. It will be a goal to determine which lentic water algae and invertebrates are acceptable as food for the fishes and other vertebrates that inhabited the lotic habitats prior to dam construction and those present after impoundments have formed. During the critical period of yolk-sac absorption, hatchlings of both migratory and non-migratory fish species depend for survival upon the availability of a limited number of acceptable first foods. The diets of older fishes as revealed by their stomach contents provide few clues to the species which the hatchlings require as first food. Therefore, conversion of a lotic to a lentic habitat may eliminate the natural first foods of the hatchlings without providing a suitable substitute or it may enhance the supply of acceptable food items. By determining the structure of the biotic communities in natural lentic and lotic habitats in the Upper Mid-Columbia System, potential food sources for hatchling and adult fishes can be identified. These will then be incorporated in simulated food webs, and likely candidates for first food, usually rotifers, microcrustaceans, or insect larvae, can easily be tested in hatcheries to validate the simulations. In addition, those species that are characteristic of special habitats will be identified as possible candidates for future biological monitoring.

Various amphibians and birds in the riparian zone may depend mainly on the emerging adult stages of aquatic insects for food. Habitat changes due to impoundment of the rivers may cause local elimination of favorite food species. The determination of community structure and construction of the computerized model food web will facilitate testing the

effects of losses of certain insect populations on resident amphibians and birds that frequent the riparian zone.

b. Rationale and significance to Regional Programs

Considerable effort is being made to protect habitats for important fish and wildlife species. During past decades, it became apparent that protection of suitable habitats was essential for protecting the local vertebrate species. However, many vertebrates are dependent upon certain biotic communities for nutrition and maintenance of conducive environmental conditions. Unfortunately, the study of the microflora and invertebrate fauna of the biotic communities has seldom been undertaken in a systematic way in many parts of the world, and community structure in some of the tributaries of the Columbia River System is poorly known, making it difficult of monitor changes and determine differences among the individual aquatic systems.

c. Relationships to other projects

The results of this study will be compared with the findings of similar research on various groups of organisms in other tributaries, including the invertebrates (9046), plants of the riparian zone (9141), and those species included in the diets of the salmon (9152) and native, non-migratory fish species (9111, 9405400). It will also provide information on algae, protozoans, and other microorganisms about which little is presently known. This will be useful in promoting understanding of the habitat preferences and food needs of locally rare, native fish species, the conservation of which is being promoted by other projects (9506402, 9152, 9111). The survey of lentic species in a naturally impounded lake will be useful for predicting developments in small lakes formed by gravel deposition impoundments (9045) and relatively new impoundments behind dams, particularly those being stocked with exotic species (9081).

d. Project history (for ongoing projects)

This is a proposal for a new project, so it has no history.

e. Proposal objectives

The product of the research will be information necessary to test the hypothesis that fish species of the water courses and impoundments, amphibians of the riparian zone, and reptiles, birds, and mammals that seek out the water bodies and wetlands for food, water, and shelter distribute themselves primarily in well defined kinds of habitat, which can be identified according to a combination of physical and chemical features and by the individual biotic communities that develop in them. In the case of the proposed investigations, the differences between lentic and lotic habitats in the same system will be determined. Although the same macrophyte and vertebrate species are found in or near both kinds of habitat, profound differences in the microbiota and invertebrate fauna can be expected. How the differences in community structure impact the diets of the fishes and

wildlife can be determined using the computerized food web model produced by this study. Background data on physical and chemical characteristics of the respective water bodies will be used to find the reasons for the differences in community structure. In addition, water analyses sometimes reveal serious pollution problems (Heckman et al, 1997). Because regions influenced by marine climates tend to support species that are active at low temperatures during winter (Heckman, 1982a), emphasis will be placed in determining seasonal differences in the food webs and their relationships to fish migration.

f. Methods

The methods used in this investigation were developed for studies of environmental impacts on streams, rivers, estuaries, and standing water bodies. They have been successfully used in studies of pesticide effects on standing water bodies along the floodplain of the Elbe River in Germany (Caspers and Heckman, 1981, 1982; Heckman, 1981, 1982b), regeneration after ecosystem destruction by release of a concentrated chlorine solution into a stream in northern Germany (Heckman, 1983), the impact of dike through estuarine marches and tidal channels along the Elbe Estuary (Heckman, 1984, 1986a), effects of dredged sediment containing heavy metals and chlorinated hydrocarbons on wetland water courses in northern Germany (Heckman, 1990), a river with extremely mineral-poor water in Mato Grosso, Brazil (Heckman, 1995), a stream contaminated by petroleum produced near the city of Belo Horizonte (Junqueira and Heckman, 1998), and to obtain baseline data on streams, rivers, and floodplains of the Pantanal in Mato Grosso, Brazil (Heckman, 1994, 1998a, b; Prado *et al*., 1994; De-Lamonica-Freire and Heckman, 1996; Hardoim and Heckman, 1996). The methods used for determining the physical factors and for the chemical analyses were described in detail by Heckman (1990, 1994, 1995, 1998b). Food webs constructed from the results of other studies were illustrated by Caspers and Heckman (1981, 1982) and Heckman (1982b, 1998b). The methods used to construct a computer simulation of a food wet were described in detail by Heckman and Hardoim (1995). The list of species found will be prepared in a way to facilitate calculation of various index values (Heckman et al., 1990) if other researchers wish to make numerical comparisons. Possible indicator species will be sought for future monitoring among the microorganisms by calculating their specific tolerance ranges for as many physical and chemical variables as possible in the field (Heckman et al., 1996). From experience, it is known that plankton and aufwuchs are the most important communities in many lentic water bodies (Heckman, 1979; Heckman and Schade, 1989; Heckman et al., 1993; Kretzschmar et al., 1993), while benthos is usually the most important in fast-flowing streams (Heckman, 1992). The emphasis will therefore be placed on each of these groups in their respective habitats.

The studies will encompass the riparian zone, the flora of which will be surveyed by video for later evaluation during each of the seasons, as described by Heckman (1989). The importance of the riparian zone in the floodplains of the river system will be determined to test the hypotheses of Heckman (1984b). The monetary value of this zone for maintaining water quality and contributing to fish production is often greatly underestimated (Heckman, 1986b). Furthermore, the littoral ecotone is an important refuge for many species and a site with an especially high species diversity (Heckman and

Kausch, 1996; Heckman, 1997), as well as the spawning grounds for a variety of aquatic animals (Kretzschmar and Heckman, 1995).

g. Facilities and equipment

The study will be completed in the field using Forest Service vehicles for visiting the sites and a set of electronic instruments and chemical analysis kits for determining the physical and chemical variables. At present, only a compound, phase contrast microscope with a photo-tubus will be required. Other equipment will be needed for collecting aquatic microorganisms for later examination under the microscope, fixing and identifying the species, and preserving the material in a reference collection.

h. Budget

Personal visits to the site to complete physical and chemical analyses, collect specimens of the flora and fauna, and provide photographic records of the collecting sites are to be supplemented by more frequent collection of material by persons to be hired during the summer months. The cost of these employees will account for about 45% of the total budget. These employees should reside near the collecting sites. Their services will be necessary to supplement the sampling and monitoring of the sites, collecting aquatic insects in light traps, recording observations of fish and wildlife species, and helping to sort the specimens collected. The only major equipment purchase is a phase contrast microscope with a photo tubus to make a record of the microorganisms observed and for producing figures in the publications. Graduate students of ecology would benefit from this kind of employment by learning the methods of collecting, fixing, and identifying various kinds of microorganisms and invertebrates. Travel between Olympia and the sampling site together with possible boat rental accounts for 6% of the cost. Chemicals and equipment for the analyses will also be necessary, although these costs are not expected to be high.

Section 9. Key personnel

Dr. Charles W. Heckman, Olympia Forest Sciences Laboratory, Pacific Northwest Research Station, 3625 93rd Ave., S.W., Olympia WA 98512.

Research scientist (fishery ecology) employed by the U. S. Forest Service. Previously employed by the Max-Planck Institute fuer Limnology, and the University of Hamburg

Academic degrees: B. S. from Manahattan College, Riverdale, New York, 1963; M. S. from St. John's University, Jamaica, New York, 1973; Dr. of Natural Sciences from the Universitaet Hamburg, Germany, 1979; Habilitation completed on the Universitaet Hamburg, 1988.

Research studies include the ecology of rice fields in Laos and Thailand, the effects of pesticides on small water bodies and wetlands along the Elbe Estuary in Germany, the

impact of construction projects on riparian wetlands, the ecology of the Pantanal of Mato Grosso, and pollution of water courses in Minas Gerais, Brazil. The results of these and other studies were reported in 61 scientific publications plus 6 in press. The publications include two books: Rice Field Ecology in Northeast Thailand and The Pantanal of Pocone. A third book on recent history, The Phnom Penh Airlift, was published in 1990.

Publications reporting the results of projects similar to that proposed here:

Heckman, C. W. 1998: The Pantanal of Pocone. Kluwer, Dordrecht. 622 pp.

Heckman, C. W. 1990: The fate of aquatic and wetland habitats in an industrially contaminated section of the Elbe floodplain in Hamburg. Arch. Hydrobiol./Suppl. 75 (Untersuch. Elbe-Aestuar 6): 133-245.

Heckman, C. W. 1986: Tidal influence on the wetland community structure behind the dike along the Elbe Estuary. Arch. Hydrobiol./Suppl. 75 (Untersuch. Elbe-Aestuar 6): 1-117.

Heckman, C. W. 1984: Effects of dike construction on the wetland ecosystem along the freshwater section of the Elbe Estuary. Arch. Hydrobiol./Suppl. 61 (Untersuch. Elbe-Aestuar 5): 397-508.

Heckman, C. W. 1979: Rice Field Ecology in Northeast Thailand. Dr. W. Junk, The Hague. 622 pp.

Section 10. Information/technology transfer

The results of the study will be published in an international journal in a format similar to many of the publications cited, and the data and computerized food web will be made available through the Forest Service.

Congratulations!