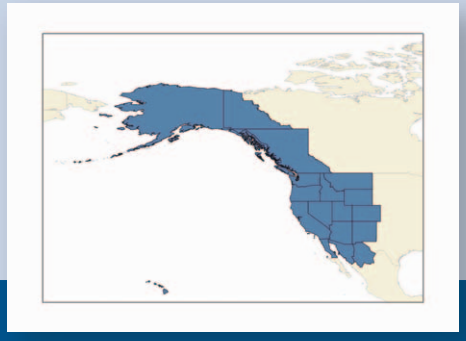
Garcia and Associates
Natural and Cultural Resource Consultants

GANDA

Phase II
Completion Report for the Western Native Fishes Database

October 2007



PREPARED FOR:

Western Division of the
American Fisheries Society

And the U.S. Fish and Wildlife Service
Multi-state Conservation Grants Program

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Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

In 2002, the Western Division of the American Fisheries Society (WDAFS) formed a committee focused on Western native fishes. In 2003, the Western Native Fishes (WNF) Committee (Committee) developed the concept of a database to track native fish distribution across the entire WDAFS territory. The WNF Project is intended to complement similar projects undertaken by the American Fisheries Society (AFS) and its collaborators to assess the status of Western anadromous salmonids (Nehlsen *et al.* 1991), crayfishes (Taylor *et al.* 1996), freshwater fishes of the Southeastern U.S. (Warren *et al.* 2000), and marine fisheries resources (Musick *et al.* 2000). These precedent projects helped narrow the species included to freshwater, primarily inland fishes. The goals of the WNF Project are to:

1. Determine the current distribution of each native freshwater fish species within the project area;
2. Determine whether current distribution has declined from historical known distribution;
3. Summarize the general abundance of each species within its areas of occurrence;
4. Identify critical habitat areas that should receive special consideration; and
5. Identify known threats to species existence.

Detailed information on the status of Western native fishes is needed to identify species and populations (i.e., evolutionarily significant units) at risk throughout Western North America. In addition, information on the status of inland native fishes is needed to evaluate the efficacy and potential impacts of recovery plans that have been developed or are being developed to facilitate the recovery of fish populations listed under the Endangered Species Act. Furthermore, such information is needed to identify key data gaps and to help focus limited state, federal, provincial, and private resources on acquiring information for the most appropriate areas (i.e., river basins, species, and stocks). The information compiled under this project will advance the management of Western native fishes by providing a source for published and unpublished information (e.g., listing petitions and in-house agency reports) on the status of a wide variety of fish species, identifying the key issues and concerns for each species, identifying critical inland native fish habitat, and clearly articulating additional information needs.

The WNF Project provides a definitive summary of the current status of inland native fishes including: an evaluation of their current distribution and status relative to prior assessments; the identification of key remaining habitat areas (refugia) for each species; and identification of key issues of concern for each species. The information used in the WNF Project is based on a review of existing status documents, identification of information gaps, a major symposium, and a survey of local experts. The WNF database includes all described native species known to exist in the Western region. For purposes of this project, the Western region is generally considered to include all of the states and provinces of the U.S. Canada and Mexico within the geographic area encompassed by the WDAFS, with the exception of the more southern states of Mexico.

Methods

Database Scope and Design

The project area included the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, the provinces of British Columbia and Yukon, and the Mexican states of Chihuahua, Sonora, and Baja California Norte (Figure 1). The WNF Committee identified 292 freshwater fish species native to the WDAFS territory, and these species became the focus of the project (Appendix A). Anandromous species were, for the most part, excluded form the scope of the project. Nomenclature was based on Nelson *et al.* 2004. The species represent 37 families and 115 genera (Table 1).

Table 1. Families and genera represented in the Western Native Fishes Database.

Family	Common Name	Number of Genera	Family	Common Name	Number of Genera
Acipenseridae	Sturgeon	2	Gobiidae	Gobie	7
Anguillidae	Eels	1	Goodeidae	Goodeid	2
Atherinopsidae	New World Silverside	1	Hiodontidae	Mooneye	1
Catostomidae	Suckers	8	Ictaluridae	Catfish	4
Centrarchidae	Sunfish	3	Kuhliidae	Flagtail	1
Characidae	Characin	1	Lepisosteidae	Gars	1
Cichlidae	Cichlid	1	Moronidae	Temperate Basses	1
Clupeidae	Herring	1	Mugilidae	Mullet	2
Cottidae	Sculpin	3	Osmeridae	Smelt	4
Cyprinidae	Minnow	37	Percidae	Perch	4
Cyprinodontidae	Killifish	2	Percopsidae	Trout-perch	1
Eleotridae	Sleeper	3	Petromyzontidae	Lamprey	1
Elopidae	Tenpounder	1	Pleuronectidae	Righteye Flounder	1
Embiotocidae	Surfperch	2	Poeciliidae	Livebearer	3
Esocidae	Pike	1	Polyodontidae	Paddlefish	1
Fundulidae	Topminnow	1	Salmonidae	Trout	6
Gadidae	Codfish	1	Sciaenidae	Drum	1
Gasterosteidae	Stickleback	3	Umbridae	Mudminnow	2

The basic informational unit used to assess occurrence and distributional status is the United States Geological Survey (USGS) fourth-level Hydrological Unit Code (i.e. 8 digit HUC). The GIS files for the fourth-level HUCs were obtained from the USGS website (http://water.usgs.gov/GIS/huc.html). GANDA delineated imilar stream order level and drainage divisions for areas of Mexico using digital elevation models (DEM) and Geographic Information System (GIS) mapping techniques. The Canadian watershed codes in the database are from the Ministry on Sustainable Resource Management's Fisheries Inventory Watershed Atlas (http://srmwww.gov.bc.ca/gis/GISdata.html). These watershed codes were used in the database to graphically display the distribution of each species. For each hydrological unit, the following information was researched for each species:

- Thought to be historically present or not?

- Known to be present or absent at the current time?
- General abundance category
- Current population status
- Threats to the species within the area (if any known)
- Key habitat areas (if any known)

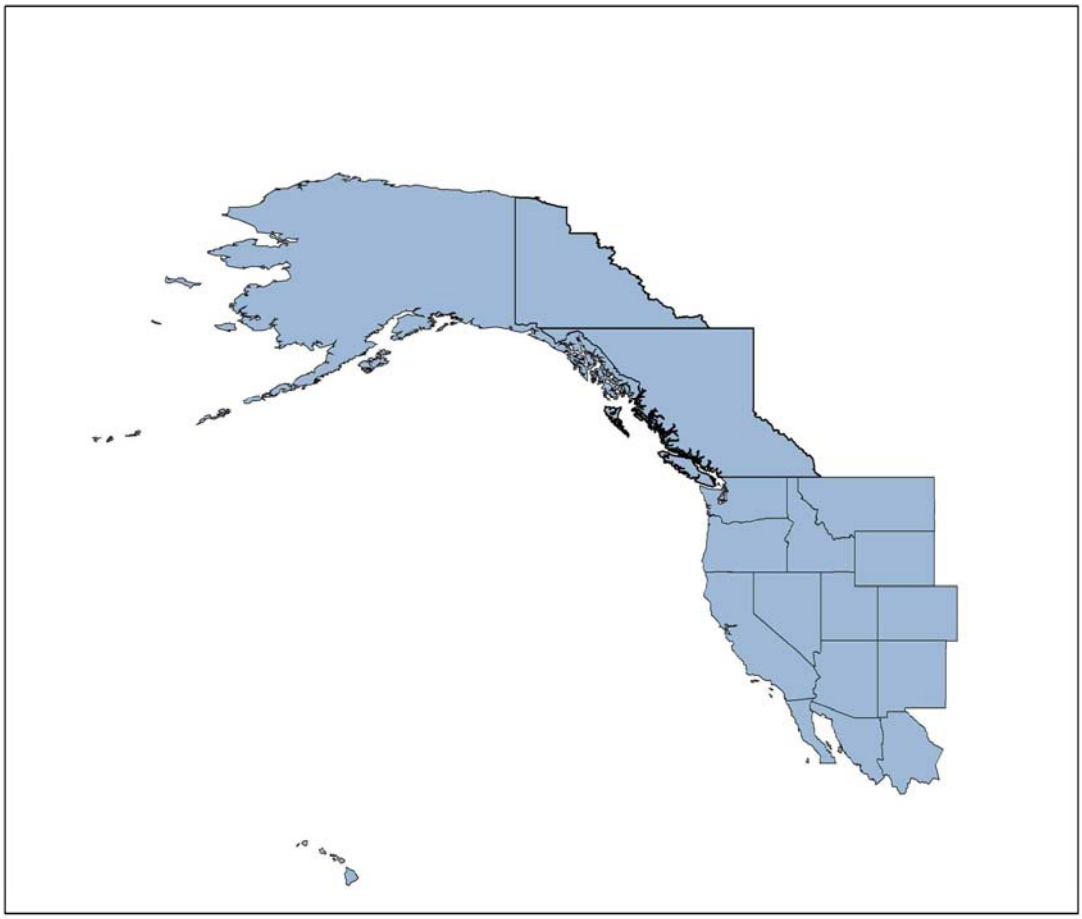

Figure 1. Project area for the Western Native Fishes Database.

GANDA developed the database design based on the Committee's input on the types of information they might request to assess species distribution trends or to develop species-specific management plans. Tables were designed to minimize data repetition while preserving relationships among data types. The primary data elements in the database are the HUC identifiers and the species names. The database was organized on the HUC, state or provincial, and species levels. Therefore, queries can be based on geographic distribution or species. We used MS Access software for the database and ArcMap 9.2 for the GIS.

The user interface is relatively simple since MS Access is not as commonly used a program as a word processor or a spreadsheet. The introductory screen allows users to read how the database was developed and the type of information it contains. Instructions for submitting potential errors and revisions are provided, as well as contact information (Figure 2). The initial intent of the committee was to have the database reviewed and updated on an annual or biannual basis. Users cannot modify tables, but if they are knowledgeable in MS Access they can construct individual queries beyond those used to generate the standard reports. After reading the introductory screen, a user can choose to search geographically or by species name, and then generate a report on screen and print it (Figure 3).

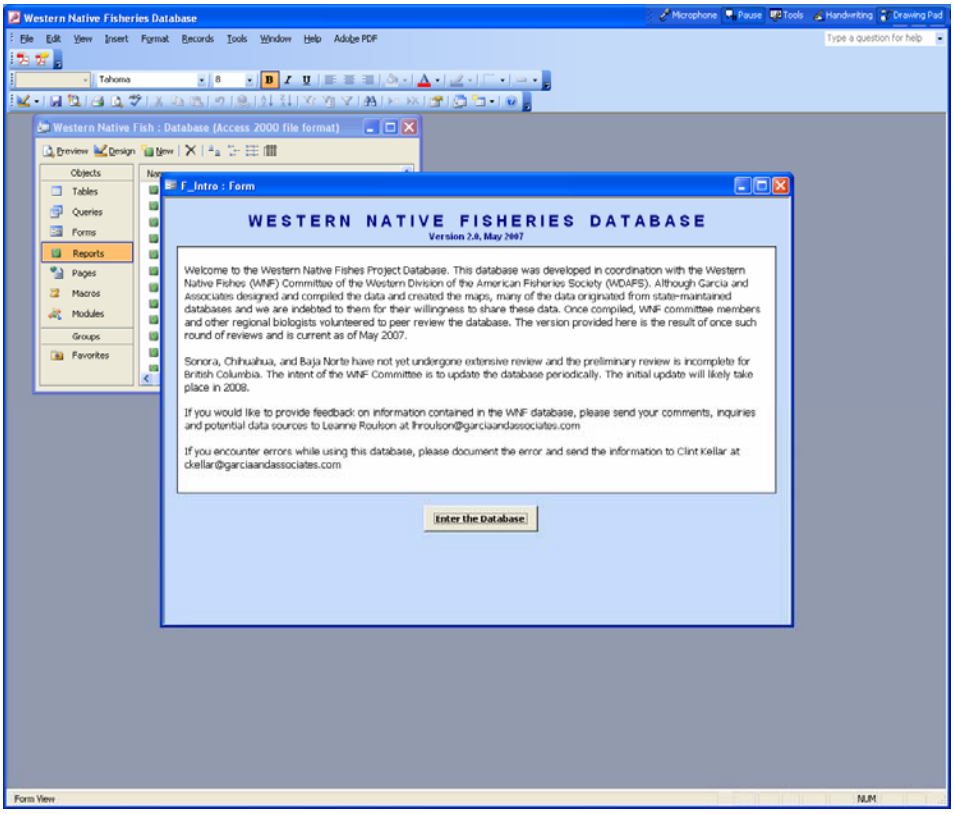

Figure 2. Introductory screen for the WNF database.

Current query options are limited to reports on individual species or on geographic areas defined by the user (Figure 3). However, now that the database is populated, one could devise additional queries and reports tailored to the information that users are most likely to request. During the initial design of the database we intentionally kept its structure simple with the idea that as the amount of information in the database increased, the types of users and the types of information requests would change. In the Discussion section, we address potential future directions for the database.

The database has several key tables including the species lookup table, the HUC table, and the species sightings and species/state tables. The species lookup table the scientific and common names as well as higher order taxonomic information. The HUC information table includes the alpha-numeric code (e.g., USGS 8-digit HUC or Provincial watershed code) used to identify the

watershed as well as their accepted names. These two tables are the basis for relating the species to their geographic distributions, and as noted earlier, constitute the primary identifying information in the WNF database structure. The species sightings table includes individual HUC records, presence/absence data and survey dates when available. The species/state table includes habitat, management or conservation status, and any additional notes on the species. For species and subspecies that are not currently recognized by AFS, we included additional narrative information in the notes, based on regional experts' survey reports.

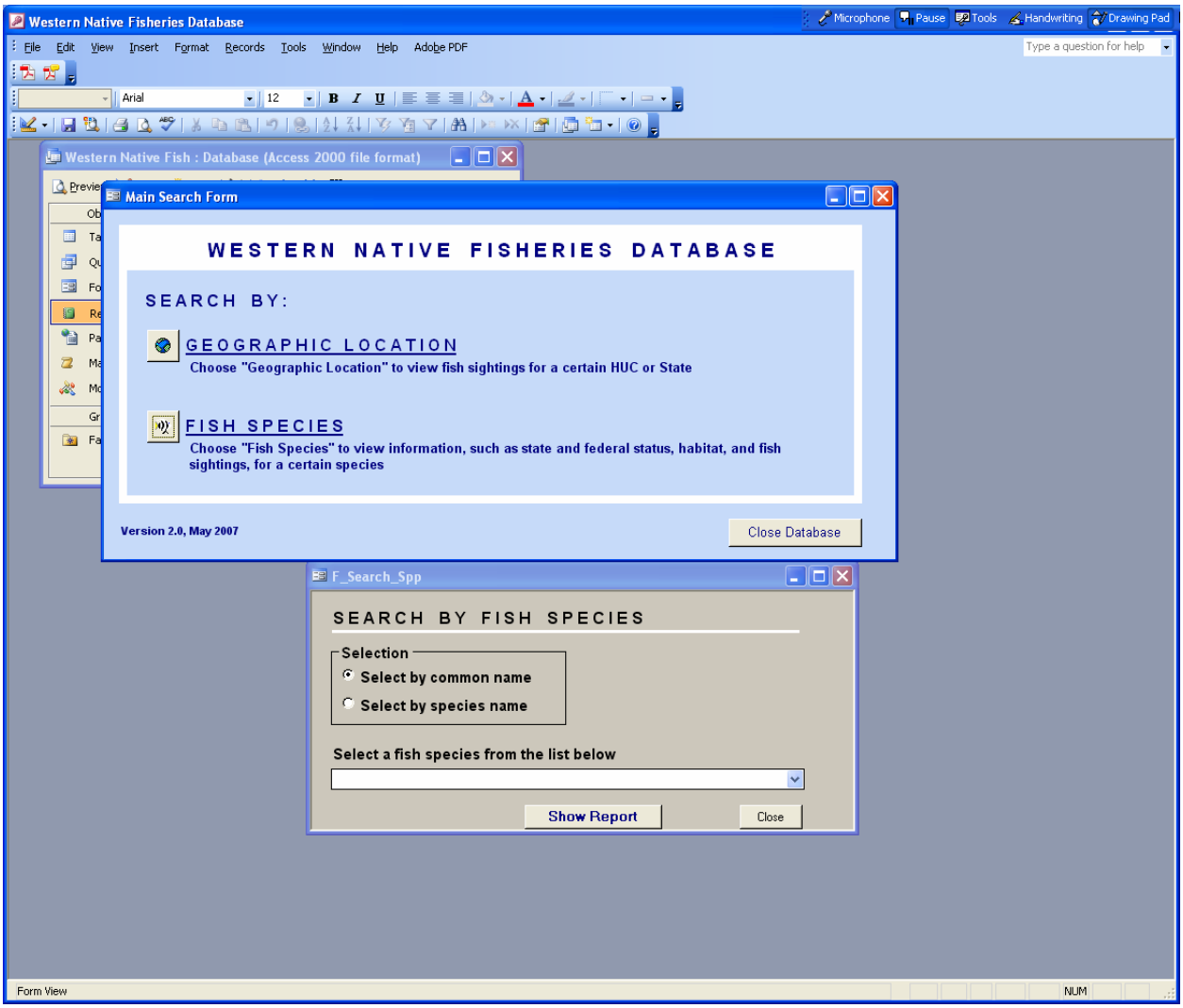

Figure 3. Search selection screen from the WNF database.

Data Collection

The primary data sources for the WNF database were existing agency-maintained databases. During the initial phase of database development we contacted fish chiefs for each state, who designated the fisheries data contact within their agency. GANDA then wrote and called each designee and determined whether or not an agency-maintained database existed and obtained permission to access or use data from each database. We provided a data layout to each database

manager who then queried their database for information on native species distributions. Although each agency-maintained database differed in structure and level of detail, in most instances the database managers were able to provide the information requested by querying their databases rather than compiling records by hand.

Other data sources included peer-reviewed literature, grey literature and agency reports, and scientific collection permit catch records. Every attempt was made to scan the literature periodically and update references for each species; however, many species had few references beyond catch records and basic life history information. With the advent of the State Wildlife Grants Program (SWG) in 2001, states had funding available to develop management plans for non-game species, which may lead to better distribution data for these species. The plans generated by states for the SWG funds vary, but many are concise compilations of information for some of the lesser-researched species included in the WNF database.

Early in the WNF database development, we worked closely with state agency fisheries biologists to develop the database design, and more recently, asked them to review data and mapping applications. In the United States we have consulted with biologists from state fish and wildlife agencies, the Environmental Protection Agency (EMAP program), the Fish and Wildlife Service, National Park Service, and National Marine Fisheries Service, as well as scientists from museums and universities. Our international efforts involved biologists from Fisheries and Oceans Canada and the Department of Environment for the Government of Yukon, and the Ministry of Environment, Environmental Stewardship Division for British Columbia. For the Mexico data, we worked with the Mexico Chapter of the AFS, as well as biologists from the scientific and university communities in Mexico.

We obtained data as electronic files whenever possible and formatted the electronic files for transfer to the database to reduce the potential for keystroke errors. Electronic files were most common for species-HUC occurrence records. Each data source was cataloged in the database references table and linked to all associated species-HUC records. The link between data sources and the raw data allows users to track down more detailed information on a record, or compile a reference list for a species. Personal knowledge of species occurrences were not acceptable data sources unless they could be confirmed by a report or data file. Additional narrative data were used to complete fields on abundance; state, provincial and federal status; and potential threats to species persistence. We relied on state and federal websites for listing status and for information on individual state management designations and practices.

Peer Review

Once the database was populated with information from each state or province, we solicited reviews from committee members, agency biologists who were not the original source of the data, and authoritative biologists recommended by WNF committee members. Peer review editors were provided with copies of the database output for their state or species and printable maps as pdf files. Reviewers compared the generated maps with the printed out data reports. Review focused on evaluating the maps and printouts for accuracy, relevance and currency. Potential errors and changes were flagged and returned to GANDA. GANDA's biologists reviewed each flagged entry and assessed it against existing data in the WNF database and

relevant references. If the change was found to be warranted, GANDA made the change in the WNF database and documented the reviewer, reference, and original entry. This process allowed us to evaluate multiple requests for changes to a single record, and will allow future reviewers to see the evolution of a record. The volunteer review efforts by the professional fisheries community were substantial, and uncovered outdated and inaccurate distributions, misidentifications, and archaic nomenclature in the original data sets. Most of the inaccuracies had been conserved from their original state databases; therefore, this review highlights the need for periodic, systematic review of any database, including the WNF project.

Mapping and GIS

We revised the database entries based on the peer reviews and regenerated the distribution maps. Each map displays the historic native and current range of each species. We based our determinations of whether a species was native to a HUC or region on published literature, state records and native species lists, and historic accounts. Within the mapped distribution individual HUCs are colored to reflect the current status of a species. For example, a game fish such as Yellowstone cutthroat trout may have been introduced to several HUCs outside its native range and extirpated from HUCs within its native range (Figure 4). For some species, the native range or current status may be in question; HUCs are classified (orange or purple) to show areas of uncertainty.

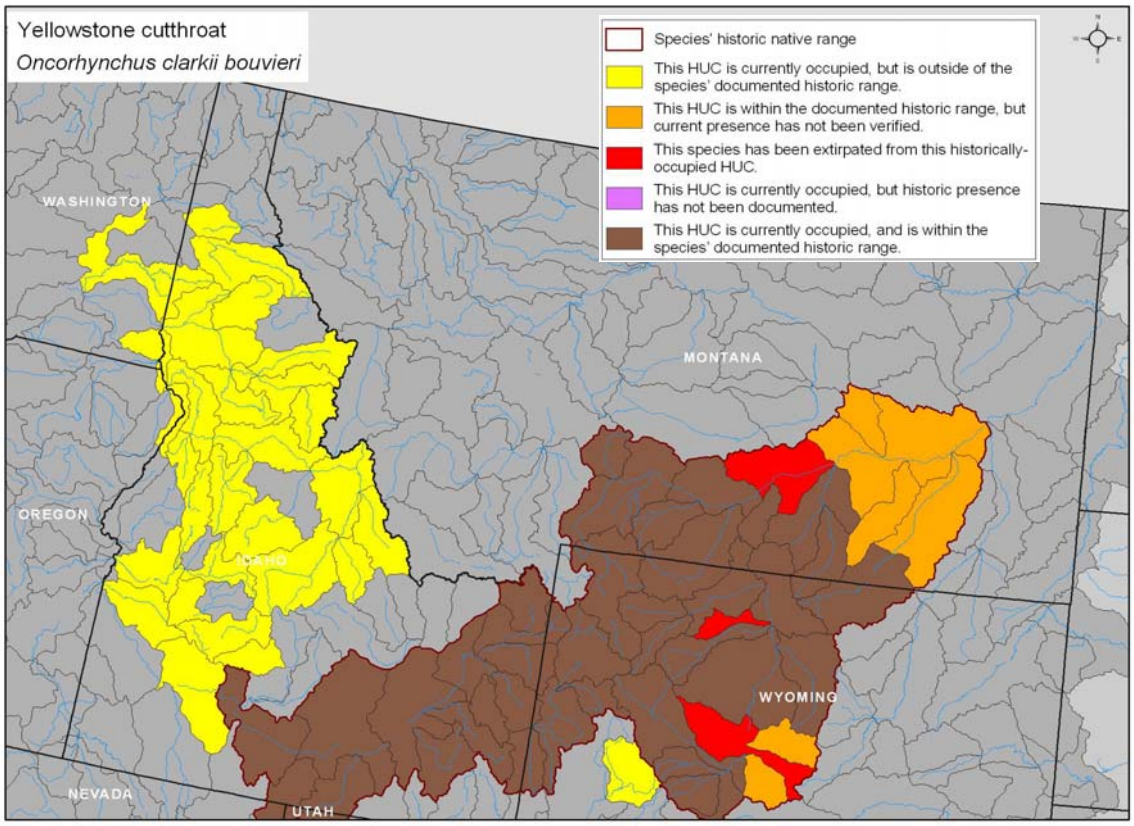

Figure 4. Map of current Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) distribution.

To increase the usefulness of the database, the WNF Committee decided to include information on species native to the WDAFS territory, but outside of their native range (shown as yellow on distribution maps). Many forage and game fish have been widely introduced throughout Western North America. Often these introductions have resulted in problems and issues in fisheries management. By including the known range of all native species, the Committee expects the database may assist fisheries managers in tracking introduced as well as native fishes. However, records on nonnative, non-game species are limited and our ability to track this information was restrained by the available data.

Distribution mapping was based on species sighting records from our literature and data source searches, and distribution was classified using information in the fields "historically present" and "currently present." If a species was shown as historically present and currently present, the GIS classified that HUC as within the species' native range and currently occupied. Similarly, if a HUC was coded as historically present but not currently present, the GIS classified that HUC as extirpated from native range. The various combinations of these two fields coupled with notations from data sources allowed us to show where species distributions were shrinking and where introductions were occurring.

Results

Distributions spanned 953 HUCs in the United States, 247 Subdrainage Watershed Boundaries in British Columbia, 46 minor Yukon watersheds, and 389 HUC-equivalents in Mexico. The area encompassed by the watersheds surveyed is approximately 1.7 billion acres.

We mapped data on historical and present distributions for 292 freshwater species native to the WDAFS territory. There are currently 13,486 species sightings entries in the database. During the peer review process, GANDA added data to or modified data from 9,483 of these records. Almost all (9,460) of the requested changes were modifications of native range (5,920) and current distribution (2,013) records. Most of the remaining changes were made to federal status records. Distribution information was available for all species, except for two lamprey species, although the level of detail, quantity of records, and age of records varied substantially among species. At the time of this report nine species are believed to be extinct and seven have been extirpated from one or more states within their native ranges (NANFA 2007). Over 75 species have been extirpated from one or more HUCs in their historical native range (Table 2).

Table 2. List of species, arranged by family, that have been extirpated from at least one HUC in their historic native range. Species believed to be extinct throughout their entire historic native range are written in bold.

Family	Common Name	Scientific Name	Family	Common Name	Scientific Name
Acipenseridae	green sturgeon	Acipenser medirostris	Cyprinidae	pearl dace	*Margariscus margarita*
	white sturgeon	Acipenser transmontanus		spikedace	*Meda fulgida*
	pallid sturgeon	Scaphirhynchus albus		hornyhead chub	*Nocomis biguttatus*

Table 2. List of species, arranged by family, that have been extirpated from at least one HUC in their historic native range. Species believed to be extinct throughout their entire historic native range are written in bold.

Family	Common Name	Scientific Name	Family	Common Name	Scientific Name
	shovelnose sturgeon	*Scaphirhynchus platorynchus*		river shiner	*Notropis blennius*
Anguillidae	American eel	*Anguilla rostrata*		blacknose shiner	*Notropis heterolepis*
Catostomidae	desert sucker	*Catostomus clarkii*		bluntnose shiner	*Notropis simus*
	white sucker	*Catostomus commersonii*		Oregon chub	*Oregonichthys crameri*
	Sonora sucker	*Catostomus insignis*		woundfin	*Plagopterus argentissimus*
	flannelmouth sucker	*Catostomus latipinnis*		flathead chub	*Platygobio gracilis*
	Modoc sucker	*Catostomus microps*		**Clear Lake splittail**	***Pogonichthys cisoides***
	Klamath largescale sucker	*Catostomus snyderi*		Colorado pikeminnow	*Ptychocheilus lucius*
	Snake River sucker	***Chasmistes muriei***		northern pikeminnow	*Ptychocheilus oregonensis*
	blue sucker	*Cycleptus elongatus*		**Las Vegas dace**	***Rhinichthys deaconi***
	razorback sucker	*Xyrauchen texanus*		Umpqua dace	*Rhinichthys evermanni*
Characidae	Mexican tetra	*Astyanax mexicanus*		speckled dace	*Rhinichthys osculus*
Cottidae	coastrange sculpin	*Cottus aleuticus*		redside shiner	*Richardsonius balteatus*
	mottled sculpin	*Cottus bairdii*	Cyprinodontidae	**Santa Cruz pupfish**	***Cyprinodon arcuatus***
	Paiute sculpin	*Cottus beldingii*		desert pupfish	*Cyprinodon macularius*

Table 2. List of species, arranged by family, that have been extirpated from at least one HUC in their historic native range. Species believed to be extinct throughout their entire historic native range are written in bold.

Family	Common Name	Scientific Name	Family	Common Name	Scientific Name
	shorthead sculpin	*Cottus confusus*	Goodeidae	**Pahrump poolfish**	***Empetrichthys latos***
	Utah Lake sculpin	***Cottus echinatus***		**Ash Meadow poolfish**	***Empetrichthys merriami***
	riffle sculpin	*Cottus gulosus*	Hiodontidae	goldeye	*Hiodon alosoides*
	Klamath Lake sculpin	*Cottus princeps*	Ictaluridae	headwater catfish	*Ictalurus lupus*
	slender sculpin	*Cottus tenuis*		channel catfish	*Ictalurus punctatus*
	Pacific staghorn sculpin	*Leptocottus armatus*		channel catfish	*Ictalurus punctatus*
Cyprinidae	beautiful shiner	*Cyprinella formosa*		stonecat	*Noturus flavus*
	roundnose minnow	*Dionda episcopa*	Osmeridae	longfin smelt	*Spirinchus thaleichthys*
	thicktail chub	***Gila crassicauda***	Percidae	sauger	*Sander canadensis*
	humpback chub	*Gila cypha*	Percopsidae	sand roller	*Percopsis transmontana*
	bonytail	*Gila elegans*	Petromyzontidae	river lamprey	*Lampetra ayresi*
	Chihuahua chub	*Gila nigrescens*		Pacific lamprey	*Lampetra tridentata*
	roundtail chub	*Gila robusta*	Poeciliidae	Gila topminnow	*Poeciliopsis occidentalis*
	California roach	*Hesperoleucus symmetricus*	Polyodontidae	paddlefish	*Polyodon spathula*
	Rio Grande silvery minnow	*Hybognathus amarus*	Salmonidae	Yellowstone cutthroat	*Oncorhynchus clarkii bouvieri*
	Western silvery minnow	*Hybognathus argyritis*		westslope cutthroat	*Oncorhynchus clarkii lewisi*

Table 2. List of species, arranged by family, that have been extirpated from at least one HUC in their historic native range. Species believed to be extinct throughout their entire historic native range are written in bold.

Family	Common Name	Scientific Name	Family	Common Name	Scientific Name
	brassy minnow	*Hybognathus hankinsoni*		**yellowfin cutthroat**	***Oncorhynchus clarkii macdonaldi***
	plains minnow	*Hybognathus placitus*		sockeye salmon/kokanee	*Oncorhynchus nerka*
	least chub	*Iotichthys phlegethontis*		pygmy whitefish	*Prosopium coulteri*
	Pahranagat spinedace	***Lepidomeda altivelis***		mountain whitefish	*Prosopium williamsoni*
	speckled chub	*Macrhybopsis aestivalis*		bull trout	*Salvelinus confluentus*
	sturgeon chub	*Macrhybopsis gelida*		Arctic grayling	*Thymallus arcticus*
	sicklefin chub	*Macrhybopsis meeki*			

Imperilment: Causes, Patterns, and Challenges

Many of the causes of imperilment for fishes in the West are similar to those described for fishes in the Southern United States (Warren et al. 2000; Fort et al. 1998). Native fishes are being replaced by introduced species and aquatic communities are becoming homogenized; these trends are exacerbated by habitat and water quality degradation (Rahel 2000). The trend of non-native introduction and resultant native species replacement is particularly strong in the West. Rahel's (2000) study found that the fish fauna in each of the states within the WDAFS territory is comprised of at least 25% non-natives, and that the states of Arizona, Nevada, and Utah had more than 50% non-native species. The Yellowstone to Yukon survey of fish distributions across the Cordilleran region (following the Rocky Mountains) of Western North America found similar changes in native fish fauna with many fish communities in southern British Columbia, Idaho and Montana dominated by introduced fish (Mayhood 2004). Ironically, fisheries managers often played a dominant role in these introductions which have commonly been the result of intentional movement of species across natural geographic barriers from one watershed to another for sport fishing or management reasons (Rahel 2007). A review of threats to

Canadian native fishes revealed that species in Canada are just as likely to be at risk due to habitat loss or degradation, but that introduced species are not as large of a factor in native species decline as in the United States (Venter *et al.* 2006).

The settling of the Western United States was strongly motivated by seemingly endless rangeland, rich mineral deposits, and great timber resources, and actions associated with harvesting these resources had dire consequences for native fisheries (Meehan 1991). Open range management and unrestricted grazing degraded prairie stream habitats and altered surface water hydrology. Clear cutting of timber and splash dam movement of cut trees introduced large amounts of sediment into streams and scoured channels. Placer and hard rock mining created large tailings piles and leached heavy metals and other pollutants into streams across the west. Areas that had previously hosted only seasonal human settlements became towns and then cities and the resultant impacts from sewage and land disturbance affected fisheries across the west.

Much of the west is considered arid; receiving less than 20 inches of annual precipitation (Fort *et al.* 1998). As settlement progressed, these arid regions experienced increased surface water demand, and diversion for irrigation and domestic uses that left some streams dry during critical rearing and spawning seasons. Where surface waters were insufficient or inaccessible, ground water resources were tapped with resultant declines in water tables and base flows in streams. At the beginning of the 19th century, engineering materials and knowledge had progressed to allow damming of large rivers which disrupted fish migrations and changed hydrology and riparian ecology (Fort *et al.* 1998). Many of these impacts continue across the west as population growth applies increasing pressures on aquatic resources.

The intensity of human impacts to native fisheries in the west is borne out by the large number of species that are listed by state, provincial, and federal agencies as deserving special status, active management or protection (Table 3). In the United States, species can be federally listed under the Endangered Species Act (ESA) of 1973, which accords the highest level of protection to a species; however, most states have additional levels of protection or special status management for species within their borders. When all levels of designation are combined for the United States, over 170 of the 292 species included in the WNF database are recognized as at risk within their respective states, and many are listed by multiple states.

Table 3. Number of species designated for special management or protection grouped by state for the Western United States (NANFA 2007).

State	Extinct	Extirpated from state	Endangered	Threatened	Any state status[a]
Alaska	0	0	0	0	0
Arizona	1	0	15	6	27
California	3	2	17	6	48
Colorado	0	1	6	1	25
Idaho	0	0	1	2	13
Montana	0	0	2	1	17
Nevada	2	1	13	6	20
New Mexico	0	1	10	6	30
Oregon	0	0	7	3	18
Utah	1	0	7	0	19

Table 3. Number of species designated for special management or protection grouped by state for the Western United States (NANFA 2007).

State	Extinct	Extirpated from state	Endangered	Threatened	Any state status[a]
Washington	0	0	1	2	13
Wyoming	1	2	5	2	18
Total Western US	8	7	39[b]	19[b]	172[b]
Total US	26	NA	74	66	NA

[a]Some states have additional levels of management status such as species of special concern, and some have a state endangered species act. This column includes all levels of listing from each state that designate special management or protection for a species.
[b] Some listed species occur in more than one state; therefore column totals may not match the regional totals.

In Canada, the Species at Risk Act (SARA) was passed in June 2003 to protect wildlife species from becoming extinct by providing for the recovery of species at risk due to human activity; and by ensuring through sound management that species of special concern do not become endangered or threatened. SARA includes prohibitions against killing, harming, harassing, capturing or taking species at risk, and against destroying their critical habitats.

In 1994 the Mexican Secretary of Environment and Natural Resources enacted legislation to recognize the need to protect, and work to identify species that are in danger of extinction, threatened, believed to be extinct in the wild, and those that are potentially in need of protection. The law, titled, NORM Mexican NOM-059-ECOL-1994, was revised substantially in 2000 and republished in 2001 with the same title. CONABIO, Mexico's agency tasked with biological conservation, develops and maintains the list of species and their respective levels of protection in NOM-059-ECOL-2001, although the list of agencies and conservation organizations involved in the development of the law and its initial species list is extensive.

Table 4. Number of species listed for special management or protection grouped by state or province Within Canada and Mexico, respectively.

	Extinct	Extirpated	Endangered	Threatened	Any state/provincial status[a]
Canadian Provinces					
British Columbia					52
Yukon					0
Total Canada	4	2	13	10	52
Mexican States					
Baja Norte		3			3
Chihuahua					2
Sonora		4			5
Total Mexico	12	8	54	61	155

Special management designations for native species have increased as has development pressure across the west. The WNF database has fields that specify identified threats for a species within a given state. These fields were only completed when a threat was identified either in an agency

report or published literature for that species. Therefore, this is not a scientifically controlled survey of threat documentation, but can shed light on how states perceived threats to their native fauna. We developed a list of threats in general categories including Habitat changes, Introduced Species and Water Conditions. Then we added subcategories to each category of threats to complete the list (Table 5).

Table 5. Pick list used to designate threats for species in the WNF database.

Category:	Habitat	Introduced species	Water conditions	Undetermined
Subcategories:	Loss- development Fragmentation	Competition Genetic mixing Hybridization Predation	Quality Availability/quantity	

Habitat loss due to development and water quality were the two most commonly identified threats to species. Habitat loss due to development was cited as the primary threat for up to 57% of a state's native species across the continental United States within the WDAFS territory and was identified as the primary threat for at least one species in every state and province. Water quality was the second most commonly identified primary threat to native species. Other primary threats identified in order of occurrence include water availability, predation by introduced species, habitat fragmentation, competition from introduced species, and hybridization either with introduced or native species. Loss of habitat and changes in habitat due to human encroachment and associated impacts to aquatic resources were identified as reasons for declines in native species across the West.

Changes in Distribution

Although the range and distribution of many of the species included in the WNF database has declined, there is no discernible pattern or common level of extent of reduction that is immediately obvious. Species with limited historical distributions are often highly specialized and may be displaced by competition with invasive species or be more likely to be impacted by stochastic events. Many of these species historically occupied fewer than five HUCs, and loss of a single HUC within their range may represent a tipping point for their continued existence. However, many of these limited-range species still occupy all of their historic range, such as the Bear Lake whitefish (*Prosopium abyssicola*), Lost River sucker (*Delistes luxatus*), and margined sculpin (*Cottus marginatus*). These records call attention to one of the potential improvements that could be made to the WNF database's display capabilities. Although population size or viability was exceedingly difficult to collect and even rarer to encounter in our data collection phase, the database is set up to hold this type of information. Once the data become available, the WNF database can be queried to generate a map that would show not only where a fish occurs, but whether the population in a HUC is known to be stable, increasing, or declining.

Regional Trends in Distribution

Areas such as the lower Colorado River and the Klamath River Basin showed a higher incidence of extirpation among native species than other major river or lake basins. Again, declines in population are not currently displayed in the maps; the only information visible on the maps is whether the species has winked out or not. These two basins are known for their recent legal battles over water for municipal and agricultural users within the United States and Mexico.

Another pattern suggests that as species decline, their distributions tend to shrink back from one edge of their range. Several species have been extirpated from the headwaters of their ranges, including the bonytail (*Gila elegans*) in the upper reaches of the Colorado River and the California roach (*Hesperoleucus symmetricus*) in Oregon. Other species have been extirpated from the mouths of the river systems they inhabit including the bluntnose shiner (*Notropis simus*) in the lower Rio Grande and the hornyhead chub (*Nocomis biguttatus*) in the North Platte River in Wyoming. The potential for introduced species to play a role in these range reductions is noteworthy.

Geographic Data Gaps

Although several agencies and data sources noted having less data than they desired for certain areas within their region, we did not identify specific areas where there was insufficient data to construct a record. Information on current freshwater fish distribution in the northern states of Mexico was the most difficult to obtain. Our current data set for Mexico comes from the *Freshwater Fishes of Mexico* (Miller and Minckley 2006). However, their final field surveys were completed in the late 1990s and although research continues, this incredible compilation, published at the end of the authors' careers and lives, is unlikely to be updated soon. Coordination with members of the Mexican Chapter AFS revealed that much of fisheries research and management in Mexico is focused on marine resources and the number of scientists working on freshwater fish resources is small. Furthermore, much of the work on freshwater fisheries resources focuses on protein yield per unit area related to reservoir management. Management of native species is not currently a common focus of continuing research.

Other areas where data were sparse often corresponded with limited human settlement or water resources. One example is the Yukon Province where fisheries biologists noted that there are not enough biologists to physically sample the large geographic area encompassed by provincial boundaries. Some areas within the United States also fit this pattern. Eastern portions of some of the Western and Pacific Northwest states had fewer surveys, or had more recently established regular surveys, so that data were often either less recent or less plentiful than more densely populated areas of the same states.

Species Data Gaps

Data were most plentiful for intensively managed games species and least plentiful for non-game fish. Unless the species was being managed due to a special designation, distribution records were often limited to presence and absence. For example, field surveys focused on trout or other games species might document the presence of minnows and suckers but might not identify them to the species level, note individual lengths, or count the number caught. It was not uncommon for agency funding to be tied to angler licenses, and the pressure to manage for bountiful recreational and commercial fisheries was acknowledged by some agency representatives. However, many states have recently instituted native and non-game species programs that perform annual surveys or require reporting for scientific collection permit holders to augment data on these less spotlighted species.

Maps for some species did call current distribution information into question. Some species distributions were discontinuous more than would be expected due to geographic barriers. For example, blue catfish (*Ictalurus furcatus*) and finescale dace (*Phoxinus neogaeus*) are known to occupy few HUCs, but it is not known whether they occur, or have ever occurred in the areas between known HUCs (Figure 5).

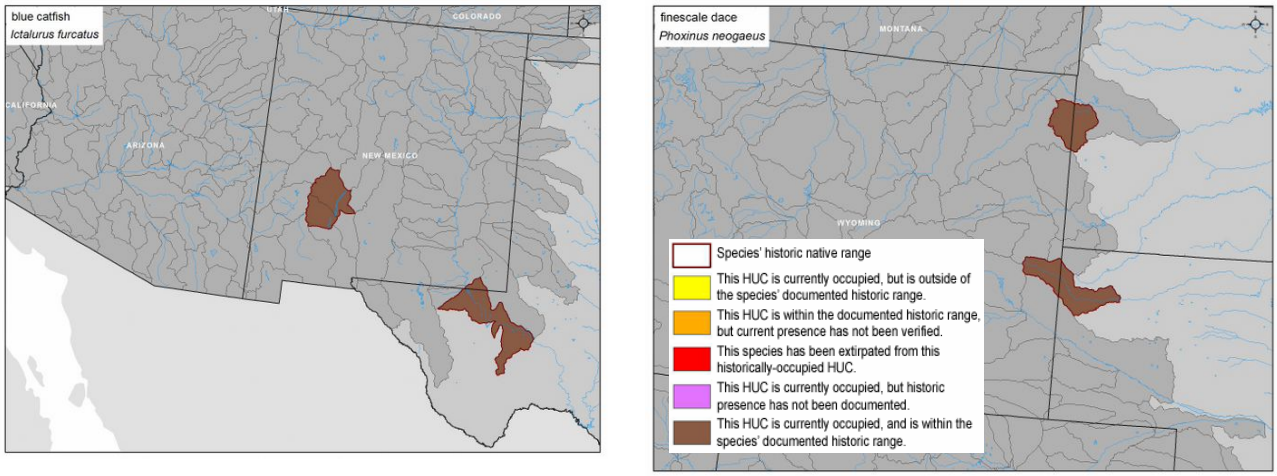

Figure 5. Examples of species with discontinuous ranges that may represent incomplete distribution information.

Maps of these discontinuous distributions may help to direct research to identify the full extent of the species' current and native ranges.

We were unable to locate data for seven species: the arrow goby (*Clevelandia ios*), Columbia sculpin (*Cottus hubbsi*), Conchos pupfish (*Cyprinodon eximius*), Vancouver lamprey (*Lampetra macrostoma*), West Mexican redhorse (*Scartomyzon austrinum*), Mississippi silvery minnow (*Hybognathus nuchalis*), and the Snake River sucker (*Chasmistes muriei*). Three species, one Centrarchidae and two Percidae, were removed from the database after our inquiries revealed that their native ranges included no HUCs within the Western Division's territory.

Information Type Data Gaps

The original data gathering objectives included entering information on population status within each HUC, general abundance, and key habitats or refugia. These data were not kept consistently by any agency or other data source we queried. Although several agencies tracked the number of fish captured in annual surveys or population estimates, these numbers were not related to how many fish the agency had set as a management goal. Some agency databases could track trends in population estimates for target species, but the wide variety of form and format for this information precluded meaningful standardization.

The WNF database contains fields to house population level information when we can develop a systematic way to assess the accuracy of each entry and tie it into a population evaluation tool. It is not that the data do not exist, it is that each group or agency has developed their own method of collecting, documenting, and filing population survey results. Standardizing and displaying the information in a categorical or quantitative fashion would require an effort much larger than that already undertaken to collect and standardize all of the general distribution data. Housing the data in a narrative form would get it into the database, but would make getting it out very tedious and analyzing it impossible. In the Discussion, we propose some intermediate steps to identify templates for the data and estimate the level of effort to convert existing data sets to a standard template for inclusion in the WNF database.

Information on habitat refugia was even less common than population trend data. If a status paper had been completed for a species, it might contain information on the general types of habitat preferred for a species at a given point in its life history, but not information on specific critical habitat. Critical habitats for federally listed species are defined geographically and are often described in more detail, but the number of federally listed species with completed critical habitat plans is very small. In an attempt to capture some of the descriptions of critical habitat, we developed categories of habitat based on flow, substrate and water temperature, but these categories do not convey the same sort of information as a narrative description, and do not take into account changes in habitat at life stages (ontogenetic shifts).

Discussion

The WNF database has compiled a large amount of information on freshwater native fishes into one resource. The database has met or exceeded many of the initial goals set out by the Committee. Distribution data have been incorporated and mapped as part of the database; however, the accuracy of the database is limited by the accuracy of the source data. Initially we took steps to prevent data input error because we assumed that this problem would be the largest potential source of error. We discovered that most state databases are not able to incorporate an effective quality control process. Quality control for regional databases is extremely time consuming and requires real-time, regionally targeted, knowledge of fisheries distribution both past and present. However, the time consuming and tedious nature of quality control often relegates it to a lower priority than on-the-ground fisheries research or management.

Data Quality

One of the greatest accomplishments of the WNF database is the extensive peer review undertaken by Committee members and volunteers. The peer review process revealed far more errors both in nomenclature and distribution records than we anticipated. To make the database project truly successful we will need to establish a feedback process by which our peer reviewed records can be assessed by the source data agencies, and incorporated into their data systems. It is important that the WNF database represent a compilation of the most accurate and professionally supported fisheries data available. We must develop a method to maintain data consistency among source data agencies and the WNF database project. Our hope is that the WNF database project will initiate two-way communication among fisheries professionals so that the peer review process can continue to improve the accuracy of our original source

databases, and data sources can continue to update species records based on on-the-ground surveys.

Use of the Database

The intended audience for the database is fisheries professionals seeking up-to-date information on species distributions and conservation concerns. The WNF Committee's goal was to produce a centralized source that can be used to track species status across political boundaries. Political boundaries are included on the distribution maps for context, but it is our hope that the mapping exercise will allow agencies to see management and research needs in light of the species' habitat boundaries and perhaps increase coordinated management among agencies.

The current user interface allows searching by geographic area or by species name (common or scientific). Species reports include distribution maps, photographs (where available), and information about special status, habitat, and references. Appendix B includes sample reports for each species currently in the database. Although the amount of information for each species is relatively succinct, availability of the summary information in one site is what distinguishes the WNF database from other regional databases.

Future Directions

This report has noted several ways that the WNF database can expand its utility within its current design. Many of these potential expansions will become more feasible as the database is updated and some of the data gaps are filled. Technology has improved over the past two years and some of our original goals for the output of the database have been surpassed by what is possible with recent mapping and database programs. The maps were by far the most powerful tool during the peer review process and were often the best way to spot problems with distribution data. The maps will most likely to be the most heavily used part of the database's output. With this use in mind, the WNF Committee understands that that the database will be much more useful and adaptable if it can communicate with the mapping program in real time. The task of updating records in the database is daunting enough without having to regenerate maps every time species distribution records are updated. Therefore, the Committee is pursuing funding for the development of a web-based GIS and database product that would not only allow database updates to be immediately reflected in the maps, but would also increase the variety of maps and reports available to users. If we are able to integrate the GIS software with the database, the user will also be able to zoom in or out on the maps, potentially link the maps to other sources of geographic information such as land cover or aerial photographs, and download the geographic distribution information for use in reports or in concert with their own data sources. The potential for spatial analyses related to apparent trends in species distribution would be greatly increased by creating this real time connection and making it available on the internet.

Housing the database on the internet would allow access by a much broader audience. Internet hosting would also remove the requirement for individual users to have MS Access installed on their computers. The committee is exploring potential hosting agencies, and GANDA has provided information on technological requirements such a server size, bandwidth, and maintenance allowances.

The committee is collaborating with the University of Redlands (University) for a potential Masters GIS student who could take on the next phase of this project. The student would design the GIS and database interface as their Masters' project using current technology and in coordination with the WNF committee. The value of using a high quality university program with GIS expertise as the designing and testing facility for the database is large. It is also a potential in-kind donation that the University will provide the student at no charge to the WDAFS. Their sponsor requirements are that we actively work with the student and periodically provide guidance and feedback on the project's progress. The University would also request that the student present the completed project at at least one of the WDAFS Chapter or Division conferences. The value of the student and faculty time might be able to be presented to potential future funding sources as matching funds. It certainly endorses the value of the project to the scientific community It will be critical to develop funding for coordination with the student and the University to ensure that the WNF database meets or exceeds the Committee's evolving goals as a cutting edge fisheries information reosurce. We now have collected the information that meets the committee's initial goals. Although getting the information together in one place was challenging and represents a great achievement, the achievement may be short-lived if the WNF database does not deliver the information to the intended audience using the most commonly queried information source, the internet. Distribution of the database has always been set aside for discussion at the completion of the project. The project is now at a point where distribution is the critical element.

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Appendices

Appendix A:
Species List for the Western Native Fishes Database

Table A-1. Species list for the Western Native Fishes database project. Species shaded in yellow have been removed from the database because they lack native range HUCs in the WDAFS territory. No data were found for species shaded in green.

Scientific Name	Common Name (English)	Mexican Name	Family	TSN[a]
Lampetra camtschatica	Arctic lamprey		Petromyzontidae	159701
Lampetra ayresi	river lamprey		Petromyzontidae	159704
Lampetra richardsoni	Western brook lamprey		Petromyzontidae	159707
Lampetra appendix	American brook lamprey		Petromyzontidae	159708
Lampetra hubbsi	Kern brook lamprey		Petromyzontidae	159709
Lampetra lethophoaga	Pit-Klamath brook lamprey		Petromyzontidae	159710
Lampetra minima	Miller Lake lamprey		Petromyzontidae	159711
Lampetra tridentata	Pacific lamprey		Petromyzontidae	159713
Lampetra macrostoma	Vancouver lamprey		Petromyzontidae	201891
Lampetra similis	Klamath lamprey		Petromyzontidae	201892
Acipenser medirostris	green sturgeon		Acipenseridae	161067
Acipenser transmontanus	white sturgeon		Acipenseridae	161068
Acipenser fulvescens	lake sturgeon		Acipenseridae	161071
Scaphirhynchus albus	pallid sturgeon		Acipenseridae	161081
Scaphirhynchus platorynchus	shovelnose sturgeon		Acipenseridae	161082
Polyodon spathula	paddlefish		Polyodontidae	161088
Lepisosteus osseus	longnose gar		Lepisosteidae	161094
Lepisosteus platostomus	shortnose gar		Lepisosteidae	161096
Elops affinis	machete		Elopidae	161112
Anguilla rostrata	American eel		Anguillidae	161127
Dorosoma cepedianum	gizzard shad		Clupeidae	161737
Dorosoma smithi	Pacific gizzard shad		Clupeidae	161741
Hiodon alosoides	goldeye		Hiodontidae	161905
Coregonus autumnalis	Arctic cisco		Salmonidae	161933
Coregonus laurettae	Bering cisco		Salmonidae	161935
Coregonus nasus	broad whitefish		Salmonidae	161936

[a] Taxonomic serial number as assigned by the Integrated Taxonomic Information System (ITIS) www.itis.gov

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Scientific Name	Common Name (English)	Mexican Name	Family	TSN[a]
Coregonus pidschian	humpback whitefish		Salmonidae	161937
Coregonus sardinella	least cisco		Salmonidae	161938
Coregonus clupeaformis	lake whitefish		Salmonidae	161941
Oncorhynchus nerka	sockeye salmon/kokanee		Salmonidae	161979
Oncorhynchus apache	Apache trout		Salmonidae	161981
Oncorhynchus clarkii	cutthroat trout		Salmonidae	161983
Oncorhynchus gilae	gila trout		Salmonidae	161985
Oncorhynchus aguabonita	golden trout		Salmonidae	161987
Oncorhynchus mykiss	rainbow trout		Salmonidae	161989
Oncorhynchus c. stomias	greenback cutthroat		Salmonidae	201901
Oncorhynchus c. henshawi	Lahontan cutthroat		Salmonidae	201902
Oncorhynchus c. lewisi	westslope cutthroat		Salmonidae	553415
Oncorhynchus c. bouvieri	Yellowstone cutthroat		Salmonidae	553416
Oncorhynchus c. macdonaldi	yellowfin cutthroat *extinct		Salmonidae	553417
Oncorhynchus m. aguabonita	golden trout		Salmonidae	553419
Oncorhynchus g. apache	Apache trout		Salmonidae	553425
Oncorhynchus c. seleniris	Paiute cutthroat		Salmonidae	553426
Oncorhynchus c. utah	Bonneville cutthroat		Salmonidae	553427
Oncorhynchus c. virginalis	Rio Grande cutthroat		Salmonidae	553428
Oncorhynchus c. pleuriticus	Colorado River cutthroat		Salmonidae	553429
Salvelinus malma	Dolly Varden		Salmonidae	162000
Salvelinus alpinus	Arctic char		Salmonidae	162001
Salvelinus namaycush	lake trout		Salmonidae	162002
Salvelinus confluentus	bull trout		Salmonidae	162004
Stenodus leucichthys	inconnu		Salmonidae	162006
Prosopium cylindraceum	round whitefish		Salmonidae	162008
Prosopium williamsoni	mountain whitefish		Salmonidae	162009
Prosopium spilonotus	Bonneville whitefish		Salmonidae	162010
Prosopium coulteri	pygmy whitefish		Salmonidae	162011

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Prosopium abyssicola	Bear Lake whitefish		Salmonidae	162012
Prosopium gemmifer	Bonneville cisco		Salmonidae	162013
Thymallus arcticus	Arctic grayling		Salmonidae	162016
Hypomesus olidus	pond smelt		Osmeridae	162031
Hypomesus transpacificus	delta smelt		Osmeridae	162032
Osmerus mordax	rainbow smelt		Osmeridae	162041
Spirinchus thaleichthys	longfin smelt		Osmeridae	162049
Thaleichthys pacificus	eulachon		Osmeridae	162051
Esox lucius	northern pike		Esocidae	162139
Dallia pectoralis	Alaska blackfish		Umbridae	162159
Novumbra hubbsi	Olympic mudminnow		Umbridae	162161
Astyanax mexicanus	Mexican tetra		Characidae	162850
Hybognathus nuchalis	Mississippi silvery minnow		Cyprinidae	163360
Hybognathus placitus	plains minnow		Cyprinidae	163361
Hybognathus argyritis	Western silvery minnow		Cyprinidae	163362
Hybognathus hankinsoni	brassy minnow		Cyprinidae	163363
Hybognathus amarus	Rio Grande silvery minnow		Cyprinidae	163365
Notemigonus crysoleucas	golden shiner		Cyprinidae	163368
Semotilus atromaculatus	creek chub		Cyprinidae	163376
Rhinichthys cataractae	longnose dace		Cyprinidae	163384
Rhinichthys evermanni	Umpqua dace		Cyprinidae	163385
Rhinichthys falcatus	leopard dace		Cyprinidae	163386
Rhinichthys osculus	speckled dace		Cyprinidae	163387
Rhinichthys cobitis	loach minnow		Cyprinidae	163388
Rhinichthys deaconi	Las Vegas dace		Cyprinidae	163390
Nocomis biguttatus	hornyhead chub		Cyprinidae	163395
Notropis atherinoides	emerald shiner		Cyprinidae	163412
Notropis simus	bluntnose shiner		Cyprinidae	163418
Notropis stramineus	sand shiner		Cyprinidae	163419

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Notropis blennius	river shiner		Cyprinidae	163429
Notropis braytoni	Tamaulipas shiner		Cyprinidae	163431
Notropis chihuahua	Chihuahua shiner		Cyprinidae	163434
Notropis dorsalis	bigmouth shiner		Cyprinidae	163439
Notropis girardi	Arkansas River shiner		Cyprinidae	163442
Notropis heterolepis	blacknose shiner		Cyprinidae	163446
Notropis jemezanus	Rio Grande shiner		Cyprinidae	163450
Phenacobius mirabilis	suckermouth minnow		Cyprinidae	163502
Campostoma anomalum	central stoneroller		Cyprinidae	163508
Campostoma ornatum	Mexican stoneroller		Cyprinidae	163510
Dionda episcopa	roundnose minnow		Cyprinidae	163513
Pimephales promelas	fathead minnow		Cyprinidae	163517
Mylocheilus caurinus	peamouth		Cyprinidae	163521
Ptychocheilus oregonensis	northern pikeminnow		Cyprinidae	163523
Ptychocheilus grandis	Sacramento pikeminnow		Cyprinidae	163524
Ptychocheilus lucius	Colorado pikeminnow		Cyprinidae	163525
Ptychocheilus umpquae	Umpqua pikeminnow		Cyprinidae	163526
Richardsonius balteatus	redside shiner		Cyprinidae	163528
Richardsonius egregius	Lahontan redside		Cyprinidae	163529
Acrocheilus alutaceus	chiselmouth		Cyprinidae	163531
Agosia chrysogaster	longfin dace		Cyprinidae	163533
Couesius plumbeus	lake chub		Cyprinidae	163535
Eremichthys acros	desert dace		Cyprinidae	163540
Gila alvordensis	Alvord chub		Cyprinidae	163542
Gila atraria	Utah chub		Cyprinidae	163543
Gila bicolor	tui chub		Cyprinidae	163544
Gila boraxobius	Borax Lake chub		Cyprinidae	163547
Gila coerulea	blue chub		Cyprinidae	163548
Gila crassicauda	thicktail chub		Cyprinidae	163550

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Scientific Name	Common Name (English)	Mexican Name	Family	TSN[a]
Gila cypha	humpback chub		Cyprinidae	163551
Gila ditaenia	Sonora chub		Cyprinidae	163552
Gila elegans	bonytail		Cyprinidae	163553
Gila nigrescens	Chihuahua chub		Cyprinidae	163554
Gila pandora	Rio Grande chub		Cyprinidae	163556
Gila purpurea	Yaqui chub		Cyprinidae	163557
Gila robusta	roundtail chub		Cyprinidae	163558
Gila intermedia	Gila chub		Cyprinidae	163560
Hesperoleucus symmetricus	California roach		Cyprinidae	163565
Iotichthys phlegethontis	least chub		Cyprinidae	163567
Lavinia exilicauda	hitch		Cyprinidae	163569
Lepidomeda albivallis	White River spinedace		Cyprinidae	163571
Lepidomeda altivelis	Pahranagat spinedace		Cyprinidae	163572
Lepidomeda mollispinis	Virgin spinedace		Cyprinidae	163573
Lepidomeda vittata	Little Colorado spinedace		Cyprinidae	163574
Meda fulgida	spikedace		Cyprinidae	163583
Moapa coriacea	Moapa dace		Cyprinidae	163585
Mylopharodon conocephalus	hardhead		Cyprinidae	163587
Orthodon microlepidotus	Sacramento blackfish		Cyprinidae	163589
Phoxinus eos	n. redbelly dace		Cyprinidae	163592
Phoxinus erythrogaster	s. redbelly dace		Cyprinidae	163593
Phoxinus neogaeus	finescale dace		Cyprinidae	163594
Plagopterus argentissimus	woundfin		Cyprinidae	163600
Pogonichthys ciscoides	Clear Lake splittail		Cyprinidae	163602
Pogonichthys macrolepidotus	splittail		Cyprinidae	163603
Relictus solitarius	relict dace		Cyprinidae	163605
Cyprinella formosa	beautiful shiner		Cyprinidae	163780
Cyprinella lutrensis	red shiner		Cyprinidae	163792
Luxilus cornutus	common shiner		Cyprinidae	163836

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Scientific Name	Common Name (English)	Mexican Name	Family	TSN[a]
Macrhybopsis aestivalis	speckled chub		Cyprinidae	163864
Macrhybopsis gelida	sturgeon chub		Cyprinidae	163866
Macrhybopsis meeki	sicklefin chub		Cyprinidae	163868
Margariscus margarita	pearl dace		Cyprinidae	163873
Oregonichthys crameri	Oregon chub		Cyprinidae	163879
Platygobio gracilis	flathead chub		Cyprinidae	163882
Cyprinella ornata	ornate shiner		Cyprinidae	
Gila eremica	desert chub	carpita del disierto	Cyprinidae	
Gila minacae	Mexican roundtail chub		Cyprinidae	
Gila nigra	headwater chub		Cyprinidae	
Gila seminuda	Virgin chub`		Cyprinidae	553395
Rhinichthys umatilla	Umatilla dace		Cyprinidae	201910
Oregonichthys kalawatseti	Umpqua chub		Cyprinidae	201929
Snyderichthys copei	leatherside chub		Cyprinidae	201945
Gila orcuttii	arroyo chub		Cyprinidae	553278
Catostomus catostomus	longnose sucker		Catostomidae	163894
Catostomus commersonii	white sucker		Catostomidae	553273
Catostomus macrocheilus	largescale sucker		Catostomidae	163896
Catostomus columbianus	bridgelip sucker		Catostomidae	163897
Catostomus ardens	Utah sucker		Catostomidae	163899
Catostomus bernardini	Yaqui sucker		Catostomidae	163900
Catostomus clarkii	desert sucker		Catostomidae	163901
Catostomus discobolus	bluehead sucker		Catostomidae	163902
Catostomus fumeiventris	Owen sucker		Catostomidae	163904
Catostomus insignis	Sonora sucker		Catostomidae	163905
Catostomus latipinnis	flannelmouth sucker		Catostomidae	163906
Catostomus microps	Modoc sucker		Catostomidae	163907
Catostomus occidentalis	Sacramento sucker		Catostomidae	163908
Catostomus platyrhynchus	mountain sucker		Catostomidae	163909

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Scientific Name	Common Name (English)	Mexican Name	Family	TSN[a]
Catostomus plebeius	Rio Grande sucker		Catostomidae	163910
Catostomus rimiculus	Klamath smallscale sucker		Catostomidae	163911
Catostomus santaanae	Santa Ana sucker		Catostomidae	163912
Catostomus snyderi	Klamath largescale sucker		Catostomidae	163913
Catostomus tahoensis	Tahoe sucker		Catostomidae	163914
Catostomus warnerensis	Warner sucker		Catostomidae	163915
Carpiodes cyprinus	quillback		Catostomidae	163917
Carpiodes carpio	river carpsucker		Catostomidae	163919
Moxostoma macrolepidotum	shorthead redhorse		Catostomidae	163928
Moxostoma congestum	gray redhorse		Catostomidae	163931
Scartomyzon austrinum	West Mexican redhorse		Catostomidae	
Cycleptus elongatus	blue sucker		Catostomidae	163953
Ictiobus bubalus	smallmouth buffalo		Catostomidae	163955
Ictiobus cyprinellus	bigmouth buffalo		Catostomidae	163956
Ictiobus niger	black buffalo		Catostomidae	163957
Chasmistes brevirostris	shortnose sucker		Catostomidae	163961
Chasmistes cujus	cui-ui		Catostomidae	163962
Chasmistes liorus	June sucker		Catostomidae	163963
Chasmistes muriei	Snake River sucker		Catostomidae	163964
Xyrauchen texanus	razorback sucker		Catostomidae	163968
Deltistes luxatus	Lost River sucker		Catostomidae	163970
Catostomus cahita	Chaita sucker		Catostomidae	
Catostomus leopoldi	fleshylip sucker		Catostomidae	
Catostomus wigginsi	Opata sucker	matalote opata	Catostomidae	
Ictalurus furcatus	blue catfish		Ictaluridae	163997
Ictalurus punctatus	channel catfish		Ictaluridae	163998
Ictalurus pricei	Yaqui catfish		Ictaluridae	164000
Ictalurus lupus	headwater catfish		Ictaluridae	164001
Noturus flavus	stonecat		Ictaluridae	164013

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Pylodictis olivaris	flathead catfish		Ictaluridae	164029
Ameiurus melas	black bullhead		Ictaluridae	164039
Percopsis omiscomaycus	trout-perch		Percopsidae	164409
Percopsis transmontana	sand roller		Percopsidae	164410
Lota lota	burbot		Gadidae	164725
Cyprinodon diabolis	Devils Hole pupfish		Cyprinodontidae	165633
Cyprinodon eximius	Conchos pupfish		Cyprinodontidae	165635
Cyprinodon macularius	desert pupfish		Cyprinodontidae	165637
Cyprinodon nevadensis	Amargosa pupfish		Cyprinodontidae	165638
Cyprinodon pecosensis	Pecos pupfish		Cyprinodontidae	165639
Cyprinodon radiosus	Owens pupfish		Cyprinodontidae	165640
Cyprinodon salinus	Salt Creek pupfish		Cyprinodontidae	165642
Cyprinodon tularosa	White Sands pupfish		Cyprinodontidae	165643
Cyprinodon albivelis	whitefin pupfish		Cyprinodontidae	
Cyprinodon arcuatus	Santa Cruz pupfish		Cyprinodontidae	
Cyprinodon eremus	Sonoyta pupfish		Cyprinodontidae	
Fundulus parvipinnis	California killifish		Fundulidae	165650
Fundulus zebrinus	plains killifish		Fundulidae	165658
Fundulus sciadicus	plains topminnow		Fundulidae	165666
Fundulus lima	Baja California killifish	sardinilla de la peninsula	Fundulidae	
Lucania parva	rainwater killifish		Cyprinodontidae	165679
Crenichthys baileyi	White River springfish		Goodeidae	165687
Crenichthys nevadae	Railroad Valley springfish		Goodeidae	165688
Empetrichthys latos	Pahrump poolfish		Goodeidae	165691
Empetrichthys merriami	Ash Meadow poolfish		Goodeidae	165692
Gambusia nobilis	Pecos gambusia		Poeciliidae	165888
Poeciliopsis occidentalis	Gila topminnow		Poeciliidae	165918
Poecilopsis lucida	clearfin livebearer	guatopote del Mocorito	Poeciliidae	
Poecilopsis monacha	headwater livebearer	guatopote del Mayo	Poeciliidae	

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Poecilopsis presidionis	Sinaloa livebearer	guatopote de Sinaloa	Poeciliidae	
Poecilopsis prolifica	blackstripe livebearer	guatopote culiche	Poeciliidae	
Menidia beryllina	inland silverside		Atherinopsidae	165993
Gasterosteus aculeatus	threespine stickleback		Gasterosteidae	166365
Pungitius pungitius	ninespine stickleback		Gasterosteidae	166387
Culaea inconstans	brook stickleback		Gasterosteidae	166399
Clinocottus acuticeps	sharpnose sculpin		Cottidae	167223
Cottus aleuticus	coastrange sculpin		Cottidae	167230
Cottus cognatus	slimy sculpin		Cottidae	167232
Cottus asper	prickly sculpin		Cottidae	167233
Cottus gulosus	riffle sculpin		Cottidae	167234
Cottus asperrimus	rough sculpin		Cottidae	167235
Cottus bairdii	mottled sculpin		Cottidae	167237
Cottus confusus	shorthead sculpin		Cottidae	167240
Cottus echinatus	Utah Lake sculpin		Cottidae	167241
Cottus extensus	Bear Lake sculpin		Cottidae	167242
Cottus greenei	Shoshone sculpin		Cottidae	167244
Cottus klamathensis	marbled sculpin		Cottidae	167245
Cottus leiopomus	Wood River sculpin		Cottidae	167246
Cottus marginatus	margined sculpin		Cottidae	167247
Cottus perplexus	reticulate sculpin		Cottidae	167248
Cottus pitensis	Pit sculpin		Cottidae	167249
Cottus princeps	Klamath Lake sculpin		Cottidae	167250
Cottus rhotheus	torrent sculpin		Cottidae	167252
Cottus ricei	spoonhead sculpin		Cottidae	167253
Cottus tenuis	slender sculpin		Cottidae	167254
Leptocottus armatus	Pacific staghorn sculpin		Cottidae	167302
Myoxocephalus quadricornis	fourhorn sculpin		Cottidae	167316
Cottus beldingi	Paiute sculpin		Cottidae	

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Cottus bendirei	Malheur sculpin		Cottidae	
Cottus hubbsi	Columbia sculpin		Cottidae	
Morone chrysops	white bass		Moronidae	167682
Kuhlia sandvicensis	Hawaiian flagfish (?flagtail?)		Kuhliidae	168085
Lepomis cyanellus	green sunfish		Centrarchidae	168132
Lepomis gulosus	warmouth		Centrarchidae	168138
Lepomis macrochirus	bluegill		Centrarchidae	168141
Lepomis megalotis	longear sunfish		Centrarchidae	168153
Micropterus salmoides	largemouth bass		Centrarchidae	168160
Archoplites interruptus	Sacramento perch		Centrarchidae	168175
Etheostoma lepidum	greenthroat darter		Percidae	168367
Etheostoma nigrum	johnny darter		Percidae	168369
Etheostoma exile	Iowa darter		Percidae	168393
Perca flavescens	yellow perch		Percidae	168469
Percina macrolepida	bigscale logperch		Percidae	168487
Sander vitreum	walleye		Percidae	168506
Sander canadense	sauger		Percidae	168509
Cichalsoma beani	Sinaloan cichlid	mojarra de Sinaloa	Cichlidae	
Aplodinotus grunniens	freshwater drum		Sciaenidae	169364
Cymatogaster aggregata	shiner perch		Embiotocidae	169739
Hysterocarpus traskii	tule perch		Embiotocidae	553322
Mugil cephalus	striped mullet		Mugilidae	170335
Mugil curema	white mullet		Mugilidae	170336
Agonostomus monticola	mountain mullet		Mugilidae	170355
Valamugil sehelia	bluespot mullet		Mugilidae	170421
Clevelandia ios	arrow goby		Gobiidae	171748
Eucyclogobius newberryi	tidewater goby		Gobiidae	171916
Dormitator latifrons	Pacific fat sleeper		Eleotridae	171918
Eleotris sandwicensis	Sandwich Island sleeper/o'opu		Eleotridae	171930

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Eleotris picta	spotted sleeper		Eleotridae	171931
Gobiomorus maculatus	Pacific sleeper		Eleotridae	
Lentipes concolor	o'opu hi'u kole		Gobiidae	171943
Gillichthys mirabilis	longjaw mudsucker		Gobiidae	171967
Awaous guamensis	o'opu nakea		Gobiidae	553326
Sicyopterus stimpsoni	Stimpson's goby		Gobiidae	553350
Stenogobius hawaiiensiss	o'opu naniha		Gobiidae	553356
Gobiesox juniperoserrai	peninsular clingfish		Gobiesocidae	
Platichthys stellatus	starry flounder		Pleuronectidae	172893
Tetraodon lineatus	globe fish / coral butterfly		Tetraodontidae	
Kuhlia marginata	dark margined flagfish (?flagtail?)		Kuhliidae	553366

Appendix B:
Selected Species Accounts from the Western Native Fishes Database

Appendix C:
Database output for all species included in the Western Native Fishes Database