



10-31-1986

## Inventory of Utah crayfish with notes on current distribution

James E. Johnson

*Utah Division of Wildlife Resources, Salt Lake City*

Follow this and additional works at: <https://scholarsarchive.byu.edu/gbn>

---

### Recommended Citation

Johnson, James E. (1986) "Inventory of Utah crayfish with notes on current distribution," *Great Basin Naturalist*. Vol. 46 : No. 4 , Article 4.

Available at: <https://scholarsarchive.byu.edu/gbn/vol46/iss4/4>

This Article is brought to you for free and open access by the Western North American Naturalist Publications at BYU ScholarsArchive. It has been accepted for inclusion in Great Basin Naturalist by an authorized editor of BYU ScholarsArchive. For more information, please contact [scholarsarchive@byu.edu](mailto:scholarsarchive@byu.edu), [ellen\\_amatangelo@byu.edu](mailto:ellen_amatangelo@byu.edu).

# INVENTORY OF UTAH CRAYFISH WITH NOTES ON CURRENT DISTRIBUTION

James E. Johnson<sup>1</sup>

**ABSTRACT.**—Crayfish distribution and composition in Utah are poorly documented. Based upon limited collections, the native *Pacifastacus gambelii* is widespread and often abundant in the Bear and Weber river drainages and is occasionally represented in smaller tributaries to the Great Salt Lake and to the Raft River. *Pacifastacus leniusculus* was collected from Utah County and *Procambarus clarkii* from Tooele County; the origin of these populations is not known. The nonnative crayfish *Orconectes virilis* is currently abundant in the Virgin, Price, and Duchesne river basins and the Glen Canyon, Flaming Gorge, Deer Creek, and Starvation reservoirs; it is expanding in Huntington North, Scofield, and Willard reservoirs. Further work is required to develop a more complete inventory and monitor the impacts on aquatic ecosystems of expanding nonnative crayfish populations. Surreptitious stockings can be dealt with only if the public is made aware of the adverse consequences of ill-conceived introductions.

Crayfish, as listed in Hobbs (1976), are represented in Utah by only one native species, *Pacifastacus (Hobbsastacus) gambelii* (Girard 1852), and that only north of approximately Salt Lake county (personal observation). Apparently crayfish are not native to the Green–Colorado River system (Dean 1969) or to that portion of the Bonneville Basin, including the Sevier River drainage, south of approximately Utah County (personal observation). Two other species of *Pacifastacus* are native to waters adjoining Utah, *Pacifastacus (Pacifastacus) leniusculus* (Dana 1852) in Nevada and *Pacifastacus (Hobbsastacus) connectens* (Faxon 1914) in Idaho (Pennak 1978) and may be native to Utah waters; however, this possibility has yet to be confirmed. *Pacifastacus leniusculus* is present in Utah County but may have been introduced there. The introduction of *Orconectes virilis* (Hagen 1870) has resulted in burgeoning populations of this nonnative in several of Utah's major drainages in recent years. One isolated population of *Procambarus (Scapulicambarus) clarkii* (Girard 1852) is found in Tooele County, probably also representing an introduction.

Crayfish feed on vegetation, and certain species have been shown to control nuisance aquatic plants (Dean 1969). They also feed on detritous and are considered important components of food webs supplying certain fisheries (Jones and Momot 1981). Their food

habits and importance as food for man and as prey for various species of sportfish have led to the widespread introduction of certain crayfish species. Since approximately 1950 *Orconectes virilis*<sup>2</sup> has been stocked in the Colorado River watershed of western New Mexico and northeastern Arizona, primarily for vegetation control (Dean 1969). During 1967, 1968, and 1970, *O. virilis* were collected by Utah Division of Wildlife Resources (UDWR) personnel from Nogal Lake in south central New Mexico, Red Lake on New Mexico's Navajo Indian Reservation, and the Little Colorado River of Arizona. These crayfish were stocked in the Sand Cove reservoirs (upper Santa Clara River drainage of the Virgin River) and Pelican Lake, Walls, Vernal Golf Course, Rasmussen and Stringham ponds (in the Vernal, Utah, area, Duchesne River drainage), and in a golf course pond adjacent to the Price River near Price, Utah. Prior to 1968 the U.S. Fish and Wildlife Service (USFWS) had planted *O. virilis* in Towave and Midway reservoirs, Uinta Indian Reservation (also Duchesne drainage).

Crayfish were reported to be a prominent food of largemouth bass at Glen Canyon Reservoir, Utah-Arizona, shortly after its impoundment (May et al. 1975), and the presence of crayfish in Flaming Gorge Reservoir, Utah-Wyoming, was confirmed during the 1970s. In neither case was the species of crayfish identified.

<sup>1</sup>Utah Division of Wildlife Resources, 1596 West North Temple, Salt Lake City, Utah 84116.

<sup>2</sup>In the opinion of Horton H. Hobbs, Jr., Smithsonian Institution, Washington, D.C., *Orconectes causeyi* (Jester 1967) is a synonym of *O. virilis* (personal communication, 1984). *Orconectes virilis* and *O. causeyi* are, therefore, collectively referred to as *O. virilis* in this paper.

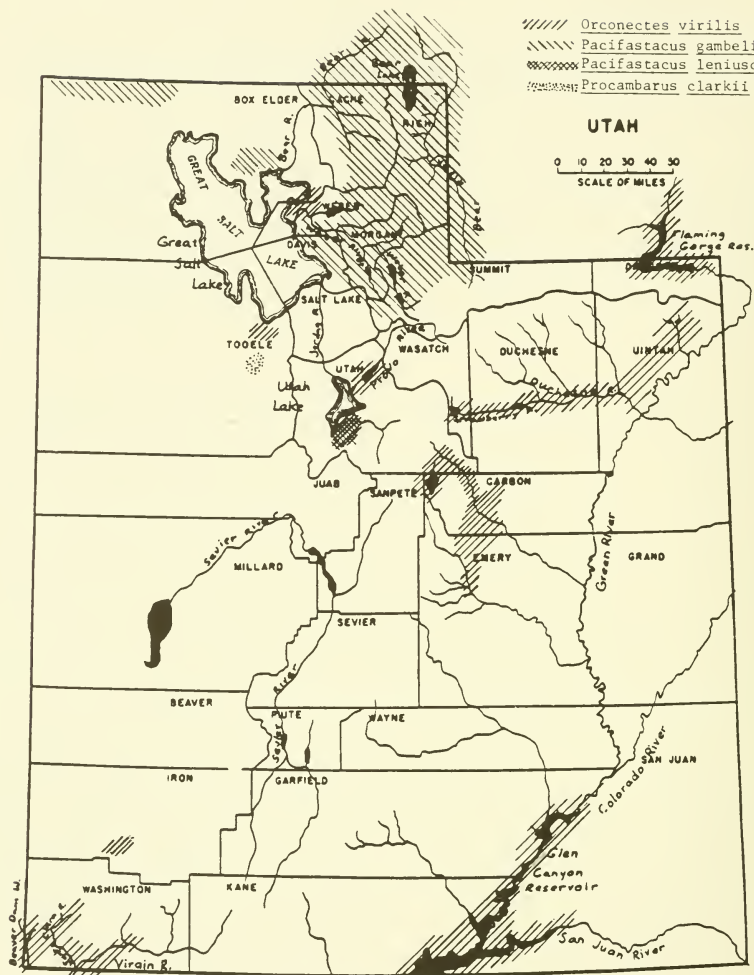


Fig. 1. Approximate current distribution of crayfish in Utah, based upon UDWR fishery collections made from 1978 to 1984.

The distribution of crayfish has spread rapidly since 1975, although the UDWR made no successful introductions after July 1977, when the Fisheries Section imposed a moratorium on further stockings. Anglers, however, observed the importance of crayfish in the diets of game fish at Lake Powell and other waters, and it is suspected that this knowledge led to a rash of surreptitious plant-

ings of crayfish by the public in additional drainages. (It is unlawful in Utah for anglers to transport live fish for bait; therefore, the bait-bucket is probably not a significant vector of crayfish in Utah.) Furthermore, previous introductions had resulted in some dense populations that were spontaneously spreading within their drainages.

The purpose of this paper is to contribute to

TABLE 1. Crayfish collection sites by UDWR fishery personnel, from which preserved specimens were made available to the author, 1978–1984.

| Drainage                     | Site                      | Collection date                 | Collector                   | Species                      |                                 |
|------------------------------|---------------------------|---------------------------------|-----------------------------|------------------------------|---------------------------------|
| COLORADO<br>Virgin River     | Lower Sand Cove           | 1982                            | D. Hepworth and J. Leppink  | <i>Orconectes virilis</i>    |                                 |
|                              | Gunlock                   | 1983                            | D. Hepworth                 | <i>Orconectes virilis</i>    |                                 |
|                              | Beaver Dam Wash           | 3 July 1984                     | W. Gustaveson               | <i>Orconectes virilis</i>    |                                 |
| Glen Canyon<br>Reservoir     | Wahweap Bay               | Composite of 1982 and 1983      | W. Gustaveson               | <i>Orconectes virilis</i>    |                                 |
|                              | San Juan Arm              | Composite of 1982 and 1983      | W. Gustaveson               | <i>Orconectes virilis</i>    |                                 |
|                              | Bullfrog Bay              | Composite of 1982 and 1983      | W. Gustaveson and S. Scott  | <i>Orconectes virilis</i>    |                                 |
| Flaming Gorge<br>Reservoir   | Near Dam                  | October 1982                    | S. Brayton                  | <i>Orconectes virilis</i>    |                                 |
| Starvation<br>Reservoir      | Boat Ramp                 | September 1983                  | M. Ottenbacher and S. Scott | <i>Orconectes virilis</i>    |                                 |
| Price River<br>Drainage      | Scofield Reservoir        | September 1984                  | W. Donaldson                | <i>Orconectes virilis</i>    |                                 |
| GREAT SALT LAKE              | Provo River               | Deer Creek Reservoir            | 21 August 1981              | D. Sakaguchi                 | <i>Orconectes virilis</i>       |
|                              | Weber River               | Willard Reservoir               | 7 December 1982             | J. Leppink                   | <i>Orconectes virilis</i>       |
|                              |                           | Morgan-Peterson                 | 16 September 1982           | J. Leppink                   | <i>Pacifastacus gambelii</i>    |
|                              | Lost Creek                | Lost Creek Reservoir            | 12 August 1984              | J. Johnson                   | <i>Pacifastacus gambelii</i>    |
|                              | Bear River                | Wellsville and Hyrum reservoirs | September 1982              | T. St. John                  | <i>Pacifastacus gambelii</i>    |
|                              | Bear River                | Bear Lake                       | Several                     | B. Nielson                   | <i>Pacifastacus gambelii</i>    |
|                              | Bear River                | Big Creek                       | 1982                        | J. Leppink                   | <i>Pacifastacus gambelii</i>    |
|                              | Great Salt Lake           | Salt Creek                      | 5 September 1984            | K. Summers                   | <i>Pacifastacus gambelii</i>    |
|                              | Utah Lake                 | Salem Pond                      | 1981                        | D. Sakaguchi                 | <i>Pacifastacus leniusculus</i> |
|                              | Utah Lake                 | Spring Pond                     | 1981                        | D. Sakaguchi                 | <i>Pacifastacus leniusculus</i> |
| COLUMBIA RIVER<br>Raft River | Cotton-Thomas Basin       | 17 August 1984                  | J. Leppink                  | <i>Pacifastacus gambelii</i> |                                 |
| WESTERN BASINS               | Rush Valley near St. John | 1978 and 17 August 1983         | D. Sakaguchi                | <i>Procambarus clarkii</i>   |                                 |

the current inventory of the distribution of crayfish in Utah and to serve as a baseline for future studies. The information presented is not comprehensive; sampling was largely by convenience rather than design, and large areas, especially Utah's western basins, were not sampled.

#### METHODS

All UDWR fishery biologists were asked to preserve in formalin all crayfish collected incidental to scheduled fish sampling. Thus, specimens were collected primarily with gill nets

and electrofishing gear. In addition, some specimens were collected by hand from the substrate rubble and using baited lift nets and cage traps. Specimens were labeled as to capture site, date, and method and sent to the author for identification. Collection sites, therefore, largely represent waters under public sportfishery management programs. Very few collection efforts were made on fishless waters.

Tentative identification was made using keys of Hobbs (1976) and Pennak (1978). Samples of each species identified, with the exception of *Pacifastacus leniusculus*, were sent to

H. H. Hobbs, Jr., Department of Invertebrate Zoology, U.S. National Museum of Natural History, Smithsonian Institution, Washington, D. C., for confirmation of my tentative identification.

## RESULTS

### Colorado-Green River Drainage

Although not endemic, crayfish are now widespread in the Utah portion of the Colorado-Green River drainage. All specimens collected to date have been *Orconectes virilis* (Fig. 1, Table 1). The species is abundant in Flaming Gorge and Glen Canyon reservoirs and in the Virgin and Duchesne drainages but has not appeared in fish collections from the San Juan, White, Yampa, Green, or Colorado rivers within Utah. It has, however, been collected from the Colorado River upstream of approximately Grand Junction, Colorado (Unger 1978).

Crayfish were apparently absent until very recently in the Strawberry River above Soldier Creek Dam, based upon their absence from extensive UDWR fish sampling of Soldier Creek and Strawberry reservoirs and their tributaries. Anglers have reported, however, that crayfish are now present in Soldier Creek Reservoir.

Reports have been received of the presence of *O. virilis* from Scofield and Huntington North reservoirs and the Price River. A specimen from Scofield Reservoir, sent to me for verification by W. Donaldson (UDWR South-eastern Regional office, Price, Utah, November 1984), proved to be *O. virilis*.

### Great Salt Lake Drainage

If crayfish were native to the Provo River drainage, the species should have been *Pacifastacus gambelii*, the documented native of the Bonneville basin (Hobbs 1972). No specimens of *P. gambelii* from the Provo River have come to my attention; however, *O. virilis* began appearing in fish sampling gear in 1981 at Deer Creek Reservoir. By 1984 they were abundant at Deer Creek Reservoir and were reported to have been seen in the Provo River downstream of Deer Creek Dam (Sakaguchi 1984).

*Orconectes virilis* was collected from the inlet of Willard Reservoir, a freshwater impoundment on the Bear River arm of the

Great Salt Lake, in November 1982. The collection site was below a large drop structure that may serve as a barrier to upstream migration of crayfish to the Weber River. I have also identified this species in Stansbury Park Lake in Tooele County near the south shore of the Great Salt Lake. These populations apparently initiated with surreptitious stockings.

*Pacifastacus gambelii* is native and widespread in the Ogden/Weber drainage. They were collected in abundance from the Weber River at Morgan in 1982 and from Lost Creek Reservoir in 1984. Crayfish have been observed by UDWR personnel in Rockport, Echo, and East Canyon reservoirs. With the exception of Willard Reservoir, only *P. gambelii* has been identified from the Weber drainage to date.

All collections to date from the Bear River have been identified as *Pacifastacus gambelii* (Table 1). The species is widespread and occasionally very abundant. No UDWR collections of crayfish have been made from the Bear River upstream of approximately the Woodruff Narrows. Wyoming Game and Fish Department personnel (W. Wengert, Green River, Wyoming, personal communication, 1984) have observed crayfish in Woodruff Narrows, Huff Creek, and Salt Creek, of the Bear River drainage. These specimens were not identified but were very likely *P. gambelii*.

*Pacifastacus gambelii* is abundant in Salt Creek, a tributary to the North Arm of the Great Salt Lake. Other tributaries to the North Arm contain crayfish but have not been inventoried.

Specimens from Salem and Spring ponds near Payson, Utah County, Utah, collected by D. Sakaguchi, were tentatively identified as *Pacifastacus leniusculus*, native to California, Oregon, Idaho, Washington, and Nevada (Pennak 1978).

The author has been informed of observations of crayfish and shallow burrows in wetlands surrounding Utah Lake, but no specimens have been collected.

### Raft River (Columbia) Drainage

Although comparatively little effort has been expended searching for crayfishes in the Raft River basin of the Columbia Drainage, *Pacifastacus gambelii* has been collected from two small tributaries (Table 1) and is thought



to be present elsewhere in the Raft River drainage.

#### Western Basins and Sevier River Drainages

Crayfish have not been observed during extensive samplings of the Pilot or Deep Creek Mountain drainages; nor have crayfish been collected from western basin natural lakes and wetlands.

*Orconectes virilis* has appeared in New-castle Reservoir in southern Iron County, apparently from sources in the adjacent Santa Clara River drainage (D. Hepworth, UDWR, personal communication, 1984).

Specimens collected by D. Sakaguchi, UDWR, from a warm spring in Rush Valley, Tooele County, in 1978 and 1983 were identified by H. Hobbs, Jr. (U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C.) to be *Procambarus clarkii*, a species common in the south central United States (Pennak 1978).

No crayfish have been reported from anywhere within the Sevier drainage. Crayfish may not be endemic to this area and, apparently, have not yet been introduced.

#### DISCUSSION

##### Colorado River Drainage

The presence of *Orconectes virilis* in the Colorado River drainage is probably the result of a number of introductions. The Santa Clara River populations originated with the UDWR introduction in 1970 at Sand Cove Reservoir in the upper Santa Clara drainage. This introduction was followed by observations of crayfish in Gunlock (1978) and Ivans (1980) reservoirs and the lower Santa Clara River and upstream through Baker Reservoir (1978). In 1983 *O. virilis* was collected from ponds along the East Fork of Beaver Dam Wash. In the Virgin River and Ash Creek, *O. virilis* is currently distributed upstream to approximately La Verkin and Toquerville, respectively. *Procambarus clarkii* is common in Lake Mead and therefore has access to the Virgin River. No *P. clarkii* have been sampled to date from the Virgin drainage of Utah, however.

The origin of *Orconectes virilis* in Glen Canyon Reservoir is less clear. One surreptitious plant of *O. virilis* is believed to have occurred in 1965, but crayfish were known to

be present in the reservoir as early as 1964 (May et al. 1975). Evidently *O. virilis* was present in the drainage at the time of impoundment or was introduced accidentally with game fish, many of which were obtained from midwestern hatcheries.

The apparent absence of crayfishes in Utah waters of the mainstem Colorado and Green rivers and the San Juan River upstream of Lake Powell deserves attention. *Orconectes virilis* now has access from both upstream and downstream and may colonize these reaches and eventually populate the White, Yampa, and other tributaries, all with unique native fish populations. *Orconectes virilis* generally occurs in relatively clear waters with stony bottoms (Pennak 1978) and may therefore prove intolerant of the Colorado system's silt-laden reaches.

The UDWR and USFWS introductions in the Uinta Basin during the period 1965–1968 resulted, by approximately 1975, in dense populations of *Orconectes virilis* in Bottle Hollow, Midview (Boreham), and numerous smaller reservoirs, as well as in the Duchesne River from its mouth upstream at least through the City of Duchesne. Although abundant in the water supply of Pelican Lake, the species has not become established in Pelican. Between 1980 and 1984 *O. virilis* appeared in Steinaker and Starvation reservoirs. The upstream extent of the current distribution of *O. virilis* in Duchesne River tributaries is presently poorly documented. The UDWR introduction in a golf course pond near Price was probably the source of the lower Price River and Huntington North Reservoir populations, but the crayfish in Scofield Reservoir probably resulted from surreptitious stockings.

Crayfish were probably absent from Flaming Gorge Reservoir and its drainage at the time of impoundment. Wyoming Game and Fish Department planted *Pacifastacus gambelii* in the Green River, between Flaming Gorge and Fontenelle reservoirs, in 1965 and 1966. The source of these crayfish was the Teton Valley Ranch near Jackson, in the Snake River drainage. In 1974 Wyoming planted largemouth bass into Flaming Gorge from Springer Pond, south of Buffalo, Wyoming. A few small crayfish were captured and stocked incidentally with the bass. The cray-

fish of Springer Pond have been identified by Wyoming Game and Fish Department (W. Wengert, Green River, Wyoming, personal communication 1984) as *Orconectes virilis*. Fish hatcheries with dirt ponds often harbor crayfish, and a variety of such hatcheries, some located within the native range of *O. virilis*, have contributed to the stocking of Flaming Gorge Reservoir over the years. This species is now abundant in Flaming Gorge Reservoir. It is the primary source of prey for the reservoir's smallmouth bass population and contributes to the diets of lake trout, brown trout, and rainbow trout (Pettengill et al. 1984).

#### Great Salt Lake Drainage

*Pacifastacus gambelii* has not been collected from Willard Reservoir; the Weber River downstream of approximately Peterson, Utah; or the Bear River from Cutler Reservoir downstream to the Great Salt Lake. Their apparent absence from these warmer waters suggests this species may be intolerant of warmer waters or of warm water fish populations. It has not been collected from the Ogden River drainage, possibly because fish toxicants were used in the reclamation of the fisheries of Pineview and Causey reservoirs.

The population of *Orconectes virilis* in Willard Reservoir is at the lower extreme of the Weber drainage. Confined by salt water downstream and a drop structure in the inlet canal, this species may not have access to the lower Weber River. If *O. virilis* succeeds in reaching the river, it can be expected to spread rapidly upstream, in a manner similar to its rapid colonization of the Duchesne and Price rivers. Furthermore, it is possible the native species will become extirpated or reduced in number in much of the Salt Lake drainage, such as occurred to native species following *O. virilis* introductions in Maryland (Schwartz et al. 1963), Tennessee, West Virginia, Mississippi (Bouchard 1976), and possibly California (Bouchard 1977, Eng and Daniels 1982). *Orconectes virilis* is a very successful and aggressive species (Bouchard 1977) and could well displace Utah's native species (H. Hobbs, Jr., personal communication, 1984). Because of the tendency of anglers to transplant crayfish, and the availability of *O. virilis* in several popular fishing waters, including Deer Creek, Flaming

Gorge, and Glen Canyon reservoirs, further appearances of *O. virilis* can be expected in waters attractive to anglers.

Only one specimen of *Pacifastacus leniusculus* each was collected from Salem and Spring ponds, Utah County. This species is clearly not as abundant or widespread as *P. gambelii*, and its origin in Utah is uncertain. If native, discovery of further populations in the Payson-Spanish Fork area, and perhaps in the western basins, can be expected.

#### Raft River (Columbia) Drainage

*Pacifastacus connectens* is reported to be native to Idaho and northern Utah (Eng and Daniels 1982). The specimens collected in the Raft River drainage proved to be *P. gambelii*, however, and no specimens of *P. connectens* have as yet come to my attention. If *P. connectens* is indeed represented in Utah, it might be expected to be present in the Columbia drainage. All future specimens from this drainage should be closely inspected; both *P. connectens* and *P. gambelii* have dorsal patches of setae on the palm of the chela, and a cursory inspection could therefore result in misidentification.

#### Western Basins and Sevier River Drainages

The waters of western Utah, within the Bonneville basin, are largely uninventoried with respect to crayfish. The only crayfish populations recorded in this area would appear to be *Orconectes virilis* in Newcastle Reservoir at the southern extreme of the basin, first observed in 1980 (the result of surreptitious stocking), and the population of *Procambarus clarkii* in a small warm spring near St. John in Rush Valley. It seems very unlikely *P. clarkii* is native, so far removed is Utah from its documented range. Introductions have resulted in established populations in California and Nevada (Pennak 1978), but any introductions of the species in this remote St. John site are undocumented and unexplained. Previous to its discovery, there was no reason to believe *P. clarkii* was present north of Lake Mead, Arizona-Nevada, and its tributaries.

Extensive fishery collections have been made in most of the Sevier River drainage and, based upon their absence from these collections, it seems reasonable to conclude crayfish are currently not in the drainage.

## NEED FOR FURTHER STUDY

Because of the rapid expansion of *Orconectes virilis* in much of Utah, expansion of this species must be closely monitored and its impacts upon sportfisheries and native fauna should be documented. In addition to its potential impact on native crayfish, there are indications of negative effects of dense populations with rainbow trout recruitment and early growth (Hepworth and Duffield, in press), and near elimination of aquatic vegetation (Dean 1969). The effects of extensive removal of vegetation on invertebrate production and availability and diversity of littoral zone fishery habitats also require study.

The rash of surreptitious stockings of crayfish in recent years demonstrates an obvious need for a thorough public information program regarding the possible consequences of indiscriminate introductions. Such a program, to be most effective, requires basis in fact and would alone justify well-conceived research into crayfish population dynamics and ecosystem interactions.

Crayfish distribution is especially poorly documented in the western basins of Utah. Furthermore, the collection of *Pacifastacus leniusculus* in Utah County raises the question of whether that species is more widely distributed around Utah Lake or in the western basins. Any crayfish specimens from Utah County or the western basins would therefore be of particular interest.

## ACKNOWLEDGMENTS

I am grateful to Dr. Horton H. Hobbs, Jr., U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., for confirming the identity of specimens from my reference collection, for identifying *Procambarus clarkii*, and for his helpful comments. Specimens were collected by virtually every regional or research UDWR biologist. In addition, specimens and collection records from the Colorado River drainage were provided by V. Lamarra and R. Valdez of Ecosystem Research Institute, Logan, Utah; R. Radant, Nongame Section, UDWR, and H. Tyus, USFWS, Vernal, Utah.

This work was accomplished in conjunction with fishery studies funded by Federal Aid to Fish Restoration Projects F-43-R and F-44-R.

## LITERATURE CITED

- BOUCHARD, R. W. 1976. Geography and ecology of crayfishes of the Cumberland Plateau and Cumberland Mountains, Kentucky, Virginia, Tennessee, Georgia, and Alabama. Part 1. The genera of *Procambarus* and *Orconectes*. *Freshwater Crayfish* 2: 563-584.
- . 1977. Distribution, systematic status and ecological notes on five poorly known species of crayfishes in western North America (Decapoda: Astacidae and Cambaridae). *Freshwater Crayfish* 3: 409-423.
- DEAN, J. L. 1969. Biology of the crayfish *Orconectes causeyi* and its use for control of aquatic weeds in trout lakes. U.S. Bureau of Sportfisheries and Wildlife, Technical Paper 24. 15 pp.
- ENG, L. L., AND R. A. DANIELS. 1982. Life history, distribution, and status of *Pacifastacus fortis* (Decapoda: Astacidae). *California Fish and Game* 68(4): 197-212.
- HEPWORTH, D. AND D. DUFFIELD. In press. Impact of an exotic crayfish on stocked rainbow trout in Newcastle Reservoir, Utah. *North American Journal of Fisheries Management*.
- HOBBS, H. H., JR. 1976. Crayfishes (Astacidae) of North and Middle America. U.S. Environmental Protection Agency Water Pollution Control Research Series, 18050 E1D05/72. Cincinnati, Ohio. 173 pp.
- JONES, P. D., AND W. T. MOMOT. 1981. Crayfish production, allochthony, and basin morphometry. *Canadian Jour. Fish. and Aqu. Sci.* 38: 175-183.
- MAY, B., C. THOMPSON, AND S. GLOSS. 1975. Impact of threadfin shad (*Dorsoma petenense*) introduction on food habits of four centrarchids. *Utah Division of Wildlife Resources, Publ.* 75-4. 22 pp.
- PENNAK, R. W. 1978. *Freshwater invertebrates of the United States*. John Wiley and Sons, New York. 803 pp.
- PETTENGILL, T., S. BRAYTON, AND J. JOHNSON. 1984 annual report. Flaming Gorge fishery investigations. *Utah Division of Wildlife Resources, Publ.* 84-07. 55 pp.
- SAKAGUCHI, D. K. 1984. Considerations for managing with crayfish in the waters of the Central Region. *Utah Division of Wildlife Resources, Central Regional Office, Springville, Utah. Memo report.* 6 pp.
- SCHWARTZ, F. J., R. RUBELMANN, AND J. ALLISON. 1963. Ecological population expansion of the introduced crayfish, *Orconectes virilis*. *Ohio Jour. of Sci.* 63(6): 266-273.
- UNGER, P. A. 1978. The crayfishes (Crustacea: Cambaridae) of Colorado. *Natural history inventory of Colorado No. 3.*, University of Colorado Museum. 20 pp.