spinedace habitat and populations. In areas of extensive habitat fragmentation, migration becomes virtually non-existent.

Agricultural practices have also modified several areas of Virgin spinedace habitat through alteration of the riparian zone. Riparian alterations often cause stream bank erosion, siltation, and devegetation. A recent evaluation of the Virgin River basin riparian zone (Fridell, Hansen, Leany, and Douglas, pers. comm., 1994) indicated that some alterations from crop production are occurring along lower La Verkin Creek, lower Ash Creek, and middle Virgin River reaches. Several reaches are impacted by livestock, including the Santa Clara River below Gunlock Reservoir, lower Santa Clara River, lower North Creek, lower La Verkin Creek, lower Ash Creek, and portions of the Virgin River mainstem. The remaining riparian zones appear to be relatively intact.

Predation, Competition, and Disease

Aquatic species introduced into the Virgin River system have been identified as contributing to reductions of native fish populations (Addley and Hardy, 1993; USFWS, 1993). Several non-indigenous fish species have been identified as occupying the same habitat as Virgin spinedace (Table 2). Several of these prey on the Virgin spinedace. Other non-indigenous species (Table 2), such as crayfish (i.e., Astacidae), may be preying on larval and young-of-year life stages in lower reaches of several tributaries (Addley and Hardy, 1993). Some non-indigenous species may also affect Virgin spinedace habitat by competing for limited resources such as food and space. Disease and parasites do not appear to have had significant roles in the declining status of the Virgin spinedace; however, they may have adverse effects when coupled with other threat and stress factors (Addley and Hardy, 1993).

Other natural or manmade factors affecting the species' continued existence.

Several other natural and manmade factors play a role in the declining status of the Virgin spinedace. Natural limiting factors include drought, flood and in some instances, natural barriers and native species interactions. The extent that natural factors affect Virgin spinedace is unclear.

Pollution from return flows, municipal drains and agriculture is a potential problem for all native species within the basin. Return flows from municipal drains and agriculture can make up a significant portion of a stream's total flow. Water from these return flows can be polluted with pesticides as well as other wastes. Mining along Beaver Dam Wash may contribute to habitat degradation. Low flows, caused naturally or by diversions, increase the impacts of pollution, erosion, siltation and mineral