5.11 *Ptychocheilus grandis* and Eel River Salmonids

Ptychocheilus grandis (also commonly known as Sacramento squawfish, Sacramento pike, chappaul, hardhead, and numerous other local names) is a large predatory minnow native to the Sacramento-San Joaquin and Russian River systems (Moyle 1976). They were introduced into the Eel River sometime during the late 1970's (Brown et al. 1987), presumably as a bait bucket release into Lake Pillsbury. Larger *P. grandis* prefer large pools in low velocity riverine habitat; they will also inhabit reservoirs. Smaller (presumably immature) *P. grandis* are found in a wide range of habitats from reservoirs to pools and riffles. Relatively high *P. grandis* populations (mostly small fish) have been documented in the mainstem Eel River summer survey sections between Scott and Cape Horn dams (Section 4.7). These survey sections are primarily riffle habitat, Preferred temperatures are between 16° and 22°C, but they can survive to 35°C (Cech et al. 1990). *P. grandis* have high reproductive potential, laying many thousands of eggs (Burns 1966), but growth is relatively slow with sexual maturity not being reached until the third or fourth year. *P. grandis* may live for 9 years or more (Taft and Murphy 1950). When young, they feed primarily on insects and plants, shifting their diets to fish and larger invertebrates as they mature.

In their native rivers, *P. grandis* co-exist with salmonids (Moyle 1976; Vondracek et al. 1989). *P. grandis* will prey upon juvenile salmonids, but the species tend to segregate much of the year based on physical characteristics (Dettman 1976; Brown and Moyle 1981). *P. grandis* favor larger pools in warmer water while the salmonids generally rear in the higher-gradient, cooler tributary habitat during the summer. When the distribution of both groups overlap, *P. grandis* tend to dominate at temperatures exceeding 15°C. The mechanisms for the dominance can be behavioral displacement (competition for food resources being implicit) or direct predation. Salmonid behavior in these rivers suggests an evolutionary response to the threat of predation. When river systems are altered by flow management, structures, or other disturbances, the balance of species may shift dramatically (Gray et al. 1984; Hall 1977; Murphy 1948).

The first *P. grandis* juveniles were captured at the Potter Valley Powerhouse in 1980 (VTN 1982). Distribution throughout the drainage appears to have been accelerated by the flood of February 1986 (SEC 1991). The species is currently present in the larger reaches of all Eel River sub-basins (Brown and Moyle 1991b; Brown and Moyle 1992). Eel River *P. grandis* populations increased dramatically during the early 1980's, making them the dominant species in the larger main channel reaches during summer months (SEC 1995, CDFG unpublished data)

P. grandis may pose a significant risk to the salmon and steelhead resources of the Eel River (Brown and Moyle, in press) This threat manifests itself in the form of direct predation and habitat displacement Predation impacts vary seasonally and may be localized (Brown 1982). Displacement can result directly from behavioral exclusion (Brown and Moyle 1991a; Brown and Brasher 1995) or increased competition for limited trophic resources. The effects of both predation and displacement can be exacerbated by alterations to the river system.

Conditions in many main channel reaches of the Eel River drainage appear to favor *P. grandis* over salmonids during certain periods of the year (SEC 1995; CDFG unpublished data). The rapid establishment of *P. grandis* is believed responsible for a significant decline in steelhead rearing densities in the mainstem Eel River between Cape Horn (Section 5.8) and Scott dams, a condition which likely effects adult escapements (Section 5.19). The structures associated with Cape Horn Dam and the Van Arsdale diversion provide habitat for *P. grandis* (A. Grass, CDFG, personal communication; L. Week, CDFG, personal communication), hence they may encourage predation. Warm summer water temperatures and low flows below Cape Horn Dam historically provided marginal steelhead rearing habitat (Kubicek 1977). Once distributed below Cape Horn Dam, *P. grandis* rapidly dominated, eliminating the limited steelhead rearing which historically existed (Section 5.8). While *P. grandis* dominate the warmer mainstem reaches, the tributaries continue to support significant populations of rearing steelhead. Juvenile salmonids emigrate from spawning and rearing areas during spring when higher flows and cooler water temperatures somewhat limit the predatory activity of *P. grandis*. *P. grandis* in the Eel River demonstrate strong seasonal migration patterns (B. Smith, USFS, personal communication). During spring, they tend to congregate in the main channel at confluences with tributaries, presumably feeding on outmigrating juvenile salmonids. Predation is likely to pose the greatest risk to the salmonids during years with lower spring flows, warmer water temperatures, and low adult salmonid escapements. As the season progresses, *P. grandis* appear to move to upstream locations including the lower reaches of some smaller tributaries for spawning. By summer, the fish older than two or three years of age tend to congregate in large and somewhat barren main channel pools during the day, migrating at night to more favorable foraging areas in nearby riffles (B. Harvey, USFS, personal communication). At the Potter Valley Project, both Lake Pillsbury and the Eel River between Scott and Cape Horn dams provide favorable habitat for *P. grandis*. Prior to the introduction of *P. grandis*, these locations both provided important salmonid habitat. Now, both areas have demonstrated significant salmonid declines coincidental with *P. grandis* increases.

The recent colonization of the Eel River by *P. grandis*, accompanied by their rapid population growth, basin-wide range expansion, and a simultaneous decline in salmonid populations, has resulted in a considerable interest on the part of resource agencies, decision makers, and special interest groups. The sense of urgency echoed by this response assumes that the presence of this predatory species will further impact salmonid fisheries which have already experienced significant declines during the past 50 years. It is important, though, that any assessment of the impact of *P. grandis* be done with the understanding that the precipitous decline of Eel River salmonids during the late 1980's paralleled a coastwide trend of similar population collapses in most river systems (sections 5.1 and 5.2). The true impact of squawfish in the Eel River will not become clear until both the Eel River and coastwide salmonid trends can be evaluated over the period of several ocean productivity cycles.

Numerous surveys and research projects have been conducted to document the magnitude of the *P. grandis* problem on the Eel River. During the mid-1980's, the Eel-Russian River Commission formed a Squawfish Task Force to gather information on the

problem. In response to angler concerns regarding the loss of the Lake Pillsbury trout fishery, CDFG has planted largemouth bass to prey upon juvenile *P. grandis*, attempted to trap *P. grandis* on their spawning migrations, conducted annual lake surveys, and planted larger "predator-resistant" trout in the lake. PG&E worked cooperatively with CDFG on mainstem population surveys, eradication studies, and depletion studies in the upper mainstem. CDFG, USFS, and other organizations have worked on numerous other survey and control projects throughout the basin, with studies ongoing. CDFG is currently formulating a plan to chemically control *P. grandis* in all inhabited waters above Cape Horn Dam. An annual *P. grandis* control program for the mainstem Eel River between Cape Horn and Scott dams has recently been proposed be PG&E, CDFG, USFWS, and NMFS.

Other strategies are worthy of consideration for minimizing the impacts from *P. grandis* in the Eel River. High priority given to tributary protection and restoration would assure the preservation of spawning and rearing habitat used exclusively by salmonids. As more tributary habitat becomes degraded and incapable of supporting salmonids, the ratio of habitat suitable for squawfish in the basin increases relative to salmonid habitat. Management for cold water releases from Scott Dam during late spring might minimize predation by *P. grandis* on newly-emerged steelhead who are actively dispersing into rearing habitat between the dams. Refinement of spring flow releases below Cape Horn Dam may enhance the timely emigration of salmonid smolts from the upper mainstem. A "no action" policy in the river may lead to stabilization of the *P. grandis* population and age structure, reducing the impact from the initial rapid expansion experienced during the early colonization period. Even with the implementation of various management options, it is questionable whether salmon and steelhead living sympatrically with *P. grandis* in the Eel River would be capable of attaining the level of reproductive success present before the introduction of *P. grandis*.