CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Limnoperna fortunei (Dunker): Golden mussel

Bivalvia: Mytilidae

Pest Rating: A

Comment Period: 02/06/2025 – 03/23/2025

Initiating Event:

Limnoperna fortunei was found in the Port of Stockton and the Victoria Canal (San Joaquin County) and the O'Neill Forebay (adjacent to the San Luis Reservoir) (Merced County). A pest rating proposal is needed.

History & Status:

Background:

Limnoperna fortunei, golden mussel (GM), is a freshwater mussel with broad environmental tolerances. GM reaches 4 cm in length and prefers to settle on hard objects, such as rocks and various manmade objects. GM is not common on muddy bottoms (Boltovskoy et al., 2009; Ionescu et al., 2005). It has external fertilization. That, the presence of a byssus, and the free-living (planktonic) immature stage, which are atypical for a freshwater bivalve, may have facilitated the human-aided dispersal of this mussel (Boltovskoy, 2015; Darrigan and Damborenea, 2011). GM attaches to a variety of natural and artificial (including ships and pipes) surfaces and can form dense aggregations (e.g., 150,000 individuals per square meter (Campos et al., 2014)). The densely aggregating and filter-feeding habits of this mussel can have significant ecological impacts in environments where it is introduced. These impacts include changes in plankton and nutrient content of water and overall abundance of animals, including fish.

GM is known to have broader environmental tolerances than the zebra mussel (Karatayev et al., 2007). Laboratory assays indicate a tolerance for water as cold as 5 °C, although it has been reported to overwinter in water as cold as 0 °C (*Limnoperna fortunei*, 2025; Oliveira et al., 2011). The maximum survivable temperature is estimated to be around 35 °C. GM can apparently tolerate calcium concentrations as low as 1 mg/L and pH as low as 6.4 (Oliveira et al., 2011). GM can survive in water as saline as 3 practical salinity units (PSUs) (Campos et al., 2014). In Brazil, a major limiting factor of the distribution appears to be high seasonal fluctuations in water level, resulting in (as water rises) decomposition of grasses that grew during low water levels and subsequent anoxia and high carbon dioxide levels (Uliano-Silva et al., 2013).

GM was introduced to a reservoir in Argentina. The filter feeding by this mussel removed particulates and chlorophyll a from the water column, making it clearer, and increased nutrient availability on the bottom and primary productivity (Boltovskoy et al., 2009). The changes, which took four to eight years to occur after introduction, could promote growth of underwater plants, which alters aquatic ecosystem composition and function.

Among the impacts attributed to introduction of *L. fortunei* are changes to the abundance of other animal species. Presence of this mussel could increase numbers of predatory fish and other organisms. In the Uruguay River, 35% of fish species and 23% of fish individuals had consumed this mussel. GM represented >10% of average gut volume of individuals in 11 species of fish and it was estimated to account for more than half of the biomass of five fish species. A fish exclusion experiment there suggests that fish are an important factor limiting the abundance of the mussel, with mussel density in open areas being approximately one-third that observed in areas where fish were excluded. It was reported that planktivorous fish consume larvae of GM and apparently the more mature mussels are fed on by fish species with strong teeth (González-Bergonzoni et al., 2019). Caddisflies (Trichoptera) in the genus *Hydropsyche* declined in abundance in a river in Japan after this mussel was introduced (Ministry of Land, Infrastructure, Transport and Tourism, in Nakano and Strayer, 2014). This could have been caused by a decrease in plankton and other particulate foods caused by filtering by the mussels, which may be (along with modification of underwater surfaces

and competition for space) a factor in the decline of a *Hydropsyche* species in the Great Lakes, which was associated with invasion by the zebra and quagga mussels (Miess et al., 2022).

GM's habit of anchoring to hard surfaces in dense aggregations has resulted in significant issues in various industrial settings, including clogged pipes, decreased flow, and increased corrosion (Cataldo et al., 2003; Ionescu et al., 2005). Planktonic larvae are difficult or impossible to filter and exclude from municipal and industrial water supply systems (Uliano-Silva et al., 2013). Water intake structures in agricultural irrigation facilities in Asia have also been clogged (Boltovskoy et al., 2015). Besides manual and mechanical cleaning, most of the control strategies listed by Boltovskoy et al. (2015) appear likely to be unfeasible for agricultural irrigation situations (e.g., methods that rely on closed conduits or chemicals that could affect water quality). This mussel has caused fouling problems in hydroelectric and nuclear power plants, as well as water treatment plants in South America (Boltovskoy et al., 2009).

Literatures suggests that ballast water carried by ships is an important mechanism of introduction of GM to new areas. For example, the introduction of this mussel to South America probably was via ballast water (Ionescu et al., 2005). This is likely how it was introduced to California as well. Shorter-distance dispersal, for example, between nearby river systems, may be accomplished through movement of boats. In Brazil, movement of fishing boats is probably the main mode of dispersal (Uliano-Silva et al., 2013).

González-Bergonzoni et al. (2019) noted that, considering the importance of this mussel in the diet of some fish species in Uruguay, preservation of fish communities could help control it.

Worldwide Distribution: GM is native to Southeastern Asia, including China. It is reported to occur in: **Asia:** China; **South America:** Argentina, Brazil, Paraguay, Uruguay; **North America:** United States (California) (Cataldo et al., 2003; Darrigran, G., and Damborenea, C. 2005; Muniz et al., 2005; Uliano-Silva et al., 2013; Zhang et al., 2022).

Official Control: GM is not under official control.

California Distribution: GM was found in the Port of Stockton and the Victoria Canal (San Joaquin County) and the O'Neill Forebay (adjacent to the San Luis Reservoir) (Merced County) in October 2024 (California Department of Food and Agriculture, 2024).

California Interceptions: GM has not been intercepted in California (California Department of Food and Agriculture, 2024).

The risk GM poses to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** GM is established in Merced and San Joaquin counties. It is a filter feeder and food is presumed to be present in most freshwater systems in California. It could likely establish over much of the state. Therefore, GM receives a **High (3)** in this category.

   – Low (1) Not likely to establish in California; or likely to establish in very limited areas.

   – Medium (2) may be able to establish in a larger but limited part of California.

   – High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** GM is a filter feeder. Therefore, it receives a **High (3)** in this category.

   – Low (1) has a very limited host range.

   – Medium (2) has a moderate host range.

   – High (3) has a wide host range.

3) **Pest Reproductive and Dispersal Potential:** GM has a free-living (planktonic) immature stage and is presumed to be dispersed via movement of water, including ballast water. It has external fertilization. Therefore, it receives a **High (3)** in this category.

   – Low (1) does not have high reproductive or dispersal potential.

   – Medium (2) has either high reproductive or dispersal potential.

   – High (3) has both high reproduction and dispersal potential.

4) **Economic Impact**. GM is reported to interfere with irrigation for agriculture, which could decrease yield and increase production costs. Therefore, it receives a **High (3)** in this category.

   Economic Impact: A, B, G

   A. The pest could lower crop yield.

   B. The pest could lower crop value (includes increasing crop production costs).

   C. The pest could trigger the loss of markets (includes quarantines).

   D. The pest could negatively change normal cultural practices.

   E. The pest can vector, or is vectored, by another pestiferous organism.

   F. The organism is injurious or poisonous to agriculturally important animals.

   G. The organism can interfere with the delivery or supply of water for agricultural uses.

   Economic Impact Score: High

   – Low (1) causes 0 or 1 of these impacts.

   – Medium (2) causes 2 of these impacts.

   – High (3) causes 3 or more of these impacts.

5) **Environmental Impact**. This mussel is reported to have significant impacts on abundance of aquatic animals and on water characteristics. This suggests the possibility of ecosystem-level

impacts in waterbodies in California. Decreased abundance of aquatic insects, which could result from GM infestation, could impact threatened or endangered species that depend on such insects. For example, the Clear Lake hitch, a minnow, feeds on aquatic insects (Clear Lake hitch, 2025). It is possible that response activities could be implemented to try to control this mussel. Therefore, GM receives a **High (3)** in this category.

Environmental Impact: A, C, D

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.

B. The pest could directly affect threatened or endangered species.

C. The pest could impact threatened or endangered species by disrupting critical habitats.

D. The pest could trigger additional official or private treatment programs.

E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: High (3)

– Low (1) causes none of the above to occur.

– Medium (2) causes one of the above to occur.

– High (3) causes two or more of the above to occur.

Consequences of Introduction to California for GM (*Limnoperna fortunei*): High (15)

Add up the total score and include it here.

–Low = 5-8 points

–Medium = 9-12 points

–High = 13-15 points

6) **Post Entry Distribution and Survey Information:** GM is established in Merced and San Joaquin counties. It receives a **Low (-1)** in this category.

–Not established (0) Pest never detected in California, or known only from incursions.

–Low (-1) Pest has a localized distribution in California, or is established in one suitable climate/host area (region).

–Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.

–High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

Final Score:

7) The final score is the consequences of introduction score minus the post entry distribution and survey information score: 14 (High)

Uncertainty:

There is a high likelihood that this mussel is present in additional localities in California. GM could be moved around with boats and disperse along canals and rivers. There is uncertainty regarding the impacts to agriculture that could occur in California. GM may potentially interfere with water delivery systems as has been observed with other invasive freshwater mussels in North America.

Conclusion and Rating Justification:

GM is a freshwater mussel that has been introduced and established widely across the world. It is a filter feeder and does not feed on vascular plants. However, it could interfere with agricultural irrigation and it is likely to have deleterious impacts on aquatic ecosystems. GM was only recently discovered in California and official control may be effective in either eradicating it or limiting its spread. For these reasons, an “A” rating is justified.

References:

Boltovskoy, D., Xu, M., and Nakano, D. 2015. Impacts of *Limnoperna fortunei* on Man-Made Structures and Control Strategies: General Overview. D. Boltovskoy (ed.), *Limnoperna fortunei*, Invading Nature - Springer Series in Invasion Ecology 10, DOI 10.1007/978-3-319-13494-9_21

Boltovskoy, D. 2015. Distribution and colonization of *Limnoperna fortunei*: Special traits of an odd mussel. Boltovskoy, D. (ed), *Limnoperna fortunei*: The Ecology, Distribution and Control of a Swiftly Spreading Invasive Fouling Mussel Springer International Publishing, Cham: 301–311.

Boltovskoy, D., Karatayev, A., Burlakova, L., Cataldo, D., Karatayev, V., Sylvester, F., and Mariñelarena, A. 2009. Significant ecosystem-wide effects of the swiftly spreading invasive freshwater bivalve *Limnoperna fortunei*. Hydrobiologia 636:271-284.
California Department of Food and Agriculture. Pest and damage record database. Accessed November 7, 2024:
https://pdr.cdfa.ca.gov/PDR/pdrmainmenu.aspx

Campos, M. D. S., de Andrade, A. F. A., Kunzmann, B., Galvão, D. D., Silva, F. A., Cardoso, A. V., Carvalho, M. D., and Mota, H. R. 2014. Modelling of the potential distribution of *Limnoperna fortunei* (Dunker, 1857) on a global scale. Aquatic Invasions 9:253-265.

Cataldo, D., Boltovsky, D., and Pose, M. 2003. Toxicity of chlorine and three nonoxidizing molluscicides to the pest mussel *Limnoperna fortunei*. Journal of the American Water Works Association 95:66-78.

Clear Lake hitch. Accessed February 5, 2025:
https://calfish.ucdavis.edu/species/?uid=33&ds=698

Darrigan, G., and Damborenea, C. 2011. Ecosystem engineering impact of *Limnoperna fortunei* in South America. Zoological Science 28:1-7.

González-Bergonzoni, I., Silva, I., de Mello, F. T., D'Anatro, A., Boccardi, L., Stebniki, S., Brugnoli, E., Tesitore, G., Vidal, N., and Naya, D. E. 2019. Evaluating the role of predatory fish controlling the invasion of the Asian golden mussel *Limnoperna fortunei* in a subtropical river. Journal of Applied Ecology DOI: 10.1111/1365-2664.13573

Ionescu, L. G., Hohemberger, J. M., Vicenzi, J., and Bergmann, C. P. 2005. Elimination and control of aquatic pests in the environment. Southern Brazilian Journal of Chemistry 13:81-90.

Karatayev, A. Y., Boltovskoy, D., Padilla, D. K., and Burlakova, L. E. 2007. The invasive bivalves *Dreissena polymorpha* and *Limnoperna fortunei*: Parallels, contrasts, potential spread and invasion impacts. Journal of Shellfish Research 26:205-213.

Limnoperna fortunei. Accessed January 13, 2025:
https://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?Species_ID=3653#

Miess, S., Chrisekos, A., and Strand, M. 2022. An ecological profile of Hydropsyche alternans (Trichoptera: Hydropsychidae) in Lake Superior, the last stronghold of a once-dominant Great Lakes surf zone caddisfly. Insects 13:1-32.

Ministry of Land, Infrastructure, Transport and Tourism. 2010. National census on river environment (dam and reservoir edition). http://mizukoku.nilim.go.jp/ksnkankyo/index.html

Muniz, P., Celemente, J., and Brugnoli, E. 2005. Benthic invasive pests in Uruguay: A new problem or an old one recently perceived? Marine Pollution Bulletin 50:993-1018.

Nakano, D., and Strayer, D. L. 2014. Biofouling animals in fresh water: biology, impacts, and ecosystem engineering. Frontiers in Ecology and the Environment 12:167-175.

Oliveira, M. D., Calheiros, D. F., Jacobi, C. M., and Hamilton, S. K. 2011. Abiotic factors controlling the establishment and abundance of the invasive golden mussel *Limnoperna fortunei*. Biological Invasions 13:717-729.

Uliano-Silva, M., Fernandes, F. F. C. F., de Holanda, I. B. B., and Rebelo, M. F. 2013. 8. Invasive species as a threat to biodiversity: The golden mussel *Limnoperna fortunei* approaching the Amazon River basin. pp. 1-14 *in* (S. Allodi, ed.) Exploring Themes on Aquatic Toxicology.

Zhang, R., Zhang, Y., Fei, X., Hou, Y., Shi, J., Li, E., and Chu, W. 2022. *Limnoperna fortunei* as an invasive biofouling bivalve species in freshwater: A review of its occurrence, biological traits, risks, and control strategies. AQUA – Water Infrastructure, Ecosystems and Society doi: 10.2166/aqua.2022.238

Responsible Party:

Kyle Beucke (see comment regarding authorship above, in Background), 1220 N Street, Sacramento, CA 95814, 916-698-3034, permits[@]cdfa.ca.gov

*Comment Period: 02/06/2025 – 03/23/2025

*NOTE:

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

Example Comment:
Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.

- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;
  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Pest Rating: A