

HAVE RESEEDINGS CONTRIBUTED TO THE STOCK ENHANCEMENT OF ABALONE IN JAPAN?

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Reseeding hatchery-reared juvenile abalone into wild populations began in late the 1970s in Japan, and now nearly 30 million juveniles are produced and released annually. Despite this, the abalone resources have not increased for many years mainly due to low natural recruitment. In the last 10 years, however, the natural recruitment and catch of the northern large species *Haliotis discus hannai* has markedly increased in some areas. The catch and natural recruitment of the southern large species, *H. discus discus*, *H. madaka* and *H. gigantea*, have shown no sign of recovery. In contrast, natural recruitment of a small abalone *H. diversicolor* found in southern Japan remains relatively high. Why has the natural recruitment of *H. discus hannai* started increasing? In southern Japan, why has the recruitment of large species remained low, while the smaller *H. diversicolor* has high natural recruitment? We can now assess whether the reseedings conducted during the last 30 years have contributed to abalone stocks in Japan.

Relatively high winter seawater temperature since the 1990s is suggested as a main factor increasing natural recruitment of *H. discus hannai*. However, this increase has only been observed in restricted areas suggesting adult populations in other areas may have been reduced to a critical level. This is probably due to low numbers of eggs, low fertilization rates, and unsuitable conditions for larval settlement and post-larval feeding in areas with low adult densities. Dense patches of males and females appear to be important for fertilization success and post-larval survival in abalone species. Adult densities are generally much lower in southern large species than in *H. discus hannai* and *H. diversicolor*. Laboratory experiments suggested that the small abalone *H. diversicolor* has greater fertilization success than larger species due to differences in spawning behavior and fertilization rates.

We conclude that millions of abalone seed released in the last 30 years have not contributed to stock rebuilding. Although reseedings apparently guaranteed a minimum catch level in many areas, natural recruitment had remained. The increase in natural recruitment of *H. discus hannai* since the 1990s was not directly caused by the reseedings. Juveniles released over a wide area might result in low densities, and these individuals could not contribute to further reproduction. Reseeding is not always effective without appropriate management of stocks for the successful reproduction. Maintaining dense adult communities and an increase in natural recruitment seems to be necessary for the recovery of stocks.