Some graduate programs have recruited and graduated students of underrepresented groups in greater proportions than has been the norm elsewhere. In this paper, I will describe in-depth case studies of several such mathematical sciences departments. Each of these departments serves different populations of students, has a distinct range of specializations, and has a unique graduate program both as described by faculty and as experienced by graduate students. Despite these differences, there are several common threads among the efforts of these programs. Overall, these practices help all students (majority and minority, female and male) in three important ways: students develop the mathematical and professional skills they will need to become professional mathematicians, they find the motivation and support they need to navigate the obstacles and challenges of graduate study, and they find ways of feeling that they belong in mathematics, developing identities as mathematicians-in-training. As a result, these programs have documented success in training PhD mathematicians of underrepresented groups. (Received September 24, 2005)