**General conclusion**

My dissertation examined weed community composition and common waterhemp population dynamics in simple versus diverse cropping systems suitable for the Midwestern United States. Measurements were taken from a field experiment employing a randomized complete block design with three crop rotations that differed in length, crop species phenology, and management requirements. Crop identity, which was the combination of a crop species and the rotation in which it occurred, was the main-plot effect, and corn weed management regime was the split-plot effect. The three crop rotations were 2-year (corn – soybean), 3-year (corn – soybean – oat intercropped with red clover), and 4-year (corn – soybean – oat intercropped with alfalfa – alfalfa). All phases of every rotation were present every year. The two corn weed management regimes were conventional (herbicide broadcast over cropped area) and low (herbicide applied over corn rows supplemented with interrow cultivation).

Chapter 1 provided the general context of the dissertation. Chapter 2 reported the aboveground weed community composition using diversity, richness, and evenness indices and the contribution of individual weed species to community abundance. Chapter 3 reported the sex ratios of waterhemp populations and provided a set of linear models to estimate waterhemp individual plant fecundity from aboveground biomass. The results of the field experiment suggested that more diverse and species-rich weed communities were found in the more diverse cropping systems. Although a lower evenness index for weed communities was recorded in the more diverse cropping systems, more of the rarer weed species were found. In addition, the relative shares among the most dominant weed species seemed to be more even in the more diverse cropping systems. Higher weed abundance in the more diverse cropping systems was coincident with reduced mass of herbicide active ingredients applied but was not coincident with crop yield decline. All the crop species at the experiment site yielded comparably between rotations and Boone County and the State of Iowa's averages. Among the weed species found at the experiment site, waterhemp dominated the seedbank and aboveground communities in terms of seed density, plant density, and aboveground mass. Waterhemp dominance was slightly lessened, and the population sex ratio was slightly female-biased, when the weed was grown with cool-season crops (oat, red clover, and alfalfa).

Chapter 4 modeled waterhemp population dynamics using the results from Chapter 3 and the scientific literature. The model used in Chapter 4 was a periodic matrix model that projected waterhemp population dynamics under low and high levels of control efficacy. Under low control efficacy, waterhemp population densities increased the slowest in the 4-year rotation and fastest in the 2-year rotation. Under high control efficacy, waterhemp population densities decreased in all rotations whose corn phase was treated with conventional weed management. Chapter 4 also simulated how waterhemp populations could be kept constant by controlling either individual plant fecundity or the mature plant survival rate.

**Management implications**

Crop identity was the most influential factor affecting waterhemp’s reproductive potential and the weed community's aboveground composition. Waterhemp's reproductive potential was reduced in the cool-season crops, and thus, its population growth rates were reduced. The results presented in the three data chapters of this dissertation indicated that stabilizing waterhemp population size was heavily dependent on reducing individual plant mass. Therefore, it is important to have multiple stressors consistently introduced to the populations of concern. The cool-season crops provided more opportunities to stunt waterhemp plants than did the warm-season crops. Since waterhemp is a summer annual species, alternating cool-season and warm-season crops would create a more conducive environment to deplete waterhemp’s soil seedbank than growing solely corn and soybean.

**Future research recommendations**

Due to labor constraints, the individual plant size of each weed species presented in Chapter 2 was not recorded. Future research could explore how individual plant size contributes to community composition, such as relative abundance and ecological indices, in multiple cropping systems to have a clearer understanding of weed community shifts.

Also due to labor constraints, waterhemp survival rates from germination to emergence and from seedlings to mature plants in each crop environment of the experiment were not measured reliably. Future efforts should be focused on measuring those rates for a more realistic population dynamics model. Waterhemp grown in cool-season crop environments, such as small grains and forages, should receive more attention because they have not been studied as thoroughly as in warm-season crop environments.

The prospective modeling exercise of this dissertation generalized all survival rates (from tolerance to chemical and physical control and herbicide resistance) in single numbers (survival rate from one time-step to another). Future research should examine how a waterhemp population's herbicide resistance profile contributes to population persistence and how resistance develops over generations in cropping systems with both cool-season and warm-season crops.