Decoys were used in controlled contexts to present some stimuli of territorial and antipredator behaviour to a number of territorial pairs.

Several discrete call types were identified, most of which were not associated exclusively with particular contexts. The situations in which call types were used did allow suggestions to be made as to the functions of the signals. Calls rendered onomatopoeically as *waahs* and *kra-was* appeared to be signals to the caller's mate, functioning, perhaps, in the coordination of pair behaviour. Two signals always produced at low volume, *urks* and *oos*, were probably used mostly in short-range aggression. Two other call types were encountered only very rarely but were linked to specific situations. Rattle calls may signal alarm at predators and may be specific to an aerial threat. Low grunts are quiet calls used only while sitting on nests and may be aimed at nestlings. All these discrete, definable call types were relatively rare in crow repertoires.

The majority of calls produced in both natural and experimental contexts were drawn from a highly variable continuum of loud and amplitude-modulated sounds. Call morphology was especially distinctive in antipredator contexts, and it also varied considerably between calls directed at territorial neighbours and those directed at conspecific intruders into territories. The decoy experiments revealed further context-related variations in the particular situations studied, but call morphology varied more strongly with respect to behaviour. From the results, I concluded that calls potentially encode information about motivation and gender and could also encode individual identity and information about call referents. The results are discussed with reference to the literature on the information content of animal signals and also with consideration of previous work investigating the relationship between structure and function.

VÁSQUEZ, R.A. 1995. Decision Making in Variable Environments: Individuals, groups and populations. DPhil Thesis. University of Oxford. Pp. 156.

This thesis examines how the variable nature of the environment affects animal decision making. In doing so, questions on individual and group foraging behaviour are addressed. Further, the implications of predation by foragers on short-term population dynamics of prey are explored. Theoretical investigations are combined with empirical studies with Starlings *Sturnus vulgaris*. The research relied heavily, but not exclusively, on studies of behavioural allocation and choice.

One experiment explored individual and group behavioural allocation in a two-patch experimental environment. Starlings foraging alone deviated from psychological accounts of allocation, namely the matching law. The deviations shown by solitary birds support optimization premises. Individual starlings foraging in groups either undermatched or did not differ from predictions of the matching law. In groups of individually matching members, groups as a whole did not conform to the habitat matching rule, a special case of ideal free distribution. A second experiment studied resource tracking by individuals and groups. Contrary to theoretical predictions, solitary starlings were more efficient at tracking prey fluctuations than were flocks of starlings. Further, patches with slow dynamics favoured prey survival.

A third investigation addressed two questions: (1) how adaptive foragers allocate behaviour among patches that vary in prey productivity, prey persistence and distance, and (2) do the short-term dynamics of prey productivity and persistence affect prey mortality and survival? A model was developed for an adaptive forager, and some of the predictions were tested with starlings. Birds showed partial agreement with the model, and the relative temporal dynamics of patches generated refuge conditions for prey. In a subsequent model, the patterns of density-dependent patch exploitation were investigated for adaptive nonomniscient foragers. Optimal decision theory was used to evaluate how a forager should exploit a patchy environment that has different resource distributions. For negative binomial distributions (e.g. contagious distribution), foragers exploited patches in a positive density-dependent manner, hence favouring conditions for prey population stability.

The thesis ends with an experiment which investigated the benefits and costs of social foraging for a highly gregarious species such as the Starling. The results showed that Starlings sacrificed feeding efficiency to be in close proximity to a flock of conspecifics. Although the experimental environment offered similar resources in different patches, Starlings showed slower gain function in social patches. Nevertheless, given the gain functions generated by their own behaviour, Starlings optimised their intake rates.

The thesis postulates that studies of behavioural allocation in changing environments can link behavioural and ecological phenomena.