FRAMING ECOLOGICAL RISK:
MASS MEDIA FRAMES IN THE
MONARCH BUTTERFLY / TRANSGENIC BT CORN CASE

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FOR PATRICK,
WYATT AND KIERA

ABSTRACT

Frames are cognitive organizational structures that break the world into understandable parts. Using frame analysis as the lens through which the public receives information about the environment provides insights about the general public understanding of conservation issues. Such analysis may also be helpful in teasing out how a potential threat to biodiversity is defined and shaped by media discourse and the stakeholders who are attempting to influence the structure of discourse. The central question of this research is *how have the U.S. mass media framed the potential ecological risks from genetically engineered organisms?* This research uses QSR NVivo (Version 2.0.163) software to explore this question through qualitative frame analyses of opinion-leading newspapers and stakeholders' documents surrounding the ecological risks of Bt corn pollen to monarch butterfly larvae. The newspaper coverage analyzed is from *The New York Times* and *The Washington Post*, which are both widely considered news leaders in the United States. In order to uncover major stakeholder frames, selected stakeholders' documents are examined to supplement and verify the analysis. Using these analyses, this research concludes with some insights about which frames are being reported or appropriated by media entities and how frame analysis enriches discussions and theory building about how risks are socially constructed, amplified, and disseminated through the cultural institution of the mass media.

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ABBREVIATIONS

ABSWG	Agricultural Biotechnology Stewardship Working Group
APHIS	Animal and Plant Health Inspection Service
Bt	*Bacillus thuringiensis*
BIO	Biotechnology Industry Organization
BRAD	Biopesticides Registration Action Document
CBD	Convention on Biological Diversity
CEC	Commission for Environmental Cooperation
CRP	Conservation Reserve Program
ECB	European Corn Borer
EPA	U.S. Environmental Protection Agency
FAO	United Nations Food and Agriculture Organization
FDA	U.S. Food and Drug Administration
GE	Genetic Engineering / Genetically Engineered
GEO	Genetically Engineered Organism
GM	Genetic Modification / Genetically Modified
HT	Herbicide Tolerant
IPM	Integrated Pest Management
IRM	Insect Resistance Management
IUCN	International Union for the Conservation of Nature
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
LOEC	Lowest Observed Effect Concentration
NAMCP	North American Monarch Conservation Plan
NAS	National Academy of Sciences (United States)
NASS	National Agricultural Statistics Service
NRC	National Research Council
NYT	*New York Times*
PIP	Plant-Incorporated Protectant
PNAS	Proceedings of the National Academy of Sciences
PR	Public relations
RBA	Risk-Benefit Analysis
SCB	Society for Conservation Biology
SCBD	Secretariat of the Convention on Biological Diversity
SWCB	Southwestern Corn Borer
SWGB	Scientists Working Group on Biosafety
T/E	Threatened and/or endangered
USDA	U.S. Department of Agriculture
WCED	World Commission on Environment and Development
WP	*Washington Post*
WTO	World Trade Organization

PREFACE

Scholarly Approach

The greatest appeal of Conservation Biology as a field of study, for me, is its multidisciplinary approach. Blossoming principally from the natural resources fields of ecology and fish and wildlife management, the field has evolved into one that now actively encourages economists and social scientists to join its ranks. The field explicitly recognizes that the conservation of the world's biodiversity will ultimately succeed or fail based on our ability to understand and change human behavior as it relates to the natural world. Yet, even as this dissertation is written, the Society of Conservation Biology's journal has published articles about the ongoing struggle to meaningfully incorporate the social sciences in its mission (Fox et al. 2006; Mascia et al. 2003; Meffe 1998; Song & M'Gonigle 2001; Thornhill 2003). As a graduate student on St. Paul's agriculture and natural resources campus of the University of Minnesota, I have observed that much of the effort to include the social sciences in our study of conservation problems has come from a fairly strict "social scientific" approach—highly quantitative, theoretical, and empirical in nature, and fitting comfortably with the biological sciences' demand for the orderly research protocol set forth in the "scientific method." However, coming from an area studies and journalism background (where examination and description of broad social and cultural context is critical), this more-or-less reductionist approach to social understanding felt constraining to me, and created a profound tension throughout my experiences in graduate school. As a result, it is important that I expose my approach to this scholarship openly from the outset, because it will undoubtedly influence how I've conducted this exploration. While the reflexive, grounded theory research approach to this research may be uncomfortable to some in the Conservation Biology field, I strongly believe the depth of this analysis would have been limited by the other approaches I considered to answer this research question.

I write as a scholar of both the biological and social aspects of conservation of biodiversity. I conceive this work as that of a social scientist, but not of one uninfluenced by the broader context of political economy, American corporatism, and personal bias. This work is based on empirical evidence that I've analyzed both quantitatively and qualitatively—limiting my interpretations to those that can be reasonably supported by the available evidence. In the vein of Priest (2002, x), my intent is to provide such interpretations and analyses in a social scientific manner—limiting my interpretations to those that can be analytically and empirically supported and avoiding those that are speculative or part of an activist agenda.

Having articulated this, however, I am compelled to divulge my role as a conservation advocate: my motivation for conducting this research is to better understand the mass media as a social institution that shapes how the general public understands and evaluates ecological risk and ultimately to use this knowledge for the purpose of conserving biodiversity. After years of studying this issue, I do believe that some forms of genetically engineered organisms, without the benefit of holistic, pre-commercialization, ecological risk assessment, may pose threats to biodiversity. I also believe that the case of the monarch butterfly larvae and Bt corn pollen should be viewed as a teachable opportunity to examine how Americans might contextualize ecological risk assessments within the broader social and cultural constructs in which they are conducted.

Dissertation Outline

Chapter One introduces agricultural biotechnology as an issue of concern for conservation biologists, highlighting the potential risks of some types of genetically engineered organisms at the four principle levels of biodiversity: genetic, population-species, community-ecosystem, and landscape. The chapter then proceeds with background information about the case study and an explication of the research question and methods.

Chapter Two is a detailed outline of the ecological risks from organisms genetically engineered to express a toxin from the bacteria *Bacillus thuringensis* (Bt)—with special emphasis on Bt corn and its potential impacts on non-target species. The bulk of the section in this chapter covering the Bt-monarch case is reprinted, with slight modification and update from its original version, from Oberhauser & Rivers (2003).

Chapter Three examines the construction of cognitive and cultural frames in the *New York Times* and *Washington Post* coverage of in the Bt-monarch case study. The chapter begins with an overall analysis of story characteristics and then proceeds through critical analysis of descriptors, definitions, images and sources used in the newspaper coverage.

Chapter Four discusses the immediate cognitive frames employed in the Bt-monarch case and the larger cultural frames evoked by the cognitive framing in the opinion-leading newspaper coverage of the Bt-monarch case. The chapter also checks the findings of the media documents against documents produced by three predominant sources referenced in the *New York Times* and *Washington Post* coverage of the Bt-monarch case. Finally, the chapter concludes with a discussion of how the present research informs current theory about the mediated social construction of risk in American society.

CHAPTER ONE
Introduction & Background

Chapter Contents

That a careful reader looking for a fact can sometimes find it with diligence and a skeptical eye tells us nothing about whether that fact received the attention and context it deserved, whether it was intelligible to the reader or effectively distorted or suppressed.

(Herman & Chomsky 1988, p. xv)

Agricultural Biotechnology & Conservation Biology

It's surprising how many conservation biologists still ask the question, "How is genetic engineering[1] (GE) a conservation biology problem?" The question has come up a number of times over the years; conservation biologists seem oddly unable or unwilling to take ownership of this issue. Remarkable, in my mind, since it was our own 1992 Convention on Biological Diversity (CBD) that first brought the development of genetic engineering to the fore as a global policy imperative and later adopted the Cartagena Protocol on Biosafety in 2000, a supplement to the CBD that addressed the need to regulate these technologies. Although some ecologists have recognized the need for more comprehensive study of the potential ecological risks from GEOs for more than two decades (most notably Kareiva, Parker & Pascual 1996; Regal 1997, 1994, 1993, 1989, 1985; Rissler & Mellon 1993; Tiedje et al. 1989), the main journal of the Conservation Biology field has published only a handful of articles addressing the subject in the past couple of decades (Adams et al. 2002; Klinger, Elam & Ellstrand 1991; Orr, 1999;

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[1] Others, especially industry sources, employ the terms "modified" or "altered" when referring to transgenic products (those organisms that have been infused with DNA from another genetically distinct organism). For the sake of consistency, I employ the terms "genetically engineered organism," "GEO(s)," and "GE" throughout these chapters when referring to transgenic organisms, as a growing number within the scientific community believe the term more accurately describes these organisms (see Snow 2003; Snow et al, 2005). Merriam-Webster (2008) also opts for the term "genetic engineering" to describe "the group of applied techniques of genetics and biotechnology used to cut up and join together genetic material and especially DNA from one species of organism and to introduce the result into an organism in order to change one or more of its characteristics." Merriam-Webster (2008) defines *modify* as making "minor changes in"; vs. *engineering* as "calculated manipulation or direction" or "application of science or mathematics by which properties of matter and the sources of energy in nature are made useful to people."

Thompson, Thompson & Burgman 2003). Indeed, it was not until its 2004 Annual Meeting that the international Society for Conservation Biology (SCB) held its first formal symposium about the ecological risks of genetic engineering and the potential impacts of the technology (positive and negative) for the conservation of biodiversity. As one of the organizers of that symposium, I am delighted that the SCB is opening itself to exploration of this issue amongst its membership. The truth is, however, that symposium and the subsequent articles that have been published to date in the Society's journal (Altieri 2005; Ehrenfeld 2006; Hill & Sendashonga 2006) have only scratched the surface of potential conservation opportunities and challenges associated with future development of the technology—and the limitations of current risk assessment methods to adequately protect global biodiversity from genetic engineering's potential impacts.

Today, molecular biologists are developing genetically engineered organisms (GEOs) throughout a wide range of taxa—fish, trees, animals, microbes, insects, and (most notably and prolifically) agricultural plants. And while some optimistically view the development of transgenic organisms as a potential tool for species conservation (e.g., Adams et al. 2002; Hoddle 2004; Stokstad 2002), conservation biologists will have to weigh the tradeoffs of these potential (and at this point, mostly theoretical) benefits against the risks GEOs present—risks that will be costly to assess, highly context-specific, and sometimes even unknowable (Ehrenfeld 2006; Regal 1997, 1993, 1988, 1985; Snow et al. 2005). As a society of biodiversity advocates, SCB will also need to grapple with whether GE strategies should be explored for conservation objectives, especially amidst shrinking conservation funding, a discussion that has only just begun in earnest (Ehrenfeld 2006).

This research focuses on ecological risks associated with one of the most prevalent types of GEO on the market today: agricultural GEOs. This introductory chapter outlines in broad terms why these particular types of GEO should be an issue of concern for conservation biologists due to the potential impact of GEOs on biological diversity at its four principle levels: genetic, population-species, community-ecosystem, and landscape (Noss 1997). Chapter Two includes a more detailed examination of specific ecological risks from Bt crops; here the objective is to highlight those challenges from GEOs issues that directly impact conservation of biodiversity.

Genetic Diversity

In terms of biodiversity at the genetic level, conservation biologists ought to be concerned about the development of agricultural GEOs for (at least) two reasons. First, there is the issue of genetic interchange between populations—engineered genetic material can flow from the GEO to native populations of the same, or different, species (Dale 1992; Ellstrand 1988; Ellstrand, Prentice & Hancock 1999; Glare & O'Callaghan 2000; Snow et al. 2005, 2003; Watrud et al. 2004). This fact, a natural and regular occurrence in nature, has the potential to "genetically pollute" native germplasms when GEOs are planted in the centers of crop origin, or the GEOs could cause unintended and unpredictable consequences when the engineered material crosses to species for which it wasn't intended, including (but not necessarily limited to) sexually compatible wild relatives (Klinger, Elam & Ellstrand 1991; Quist & Chapela 2002, 2001; Regal 1997). For example, consider a scenario where genetic material that confers resistance to a pesticide flows from an agricultural plant to a native plant common to that locale. If the pesticide resistance trait gives that native variety a fitness advantage over other native varieties of the same species, intra-species genetic diversity could dwindle as the resistant/tolerant variety out-competes other native varieties. Such a competitive advantage would be derived from a kind of "manufactured selection" that is based on a relatively short-term human interest. Where it was previously assumed that commercialized agricultural crops would suffer from decreased fitness from years of breeding for specific trait expression, GE may enable the application of specific traits without the deleterious effects of traditional breeding, which involves genetic manipulation only in sexually compatible species (Regal 1997, 1993, 1988ab).

A related issue at the genetic level, for those concerned with conservation of *agricultural* biodiversity, is the issue of maintaining allelic diversity in crop plants (Abbo & Rubin 2000; Brush 2004). Since engineering crop species for increased production is merely an extension of creating agricultural monocultures, the loss of allelic diversity (also called "genetic erosion") amongst crop species is only accelerated by the advent of genetic engineering, whose parent lines are usually only the most commercialized and widely used cultivars (Rosset 2002; Vallve 1993). The UN Food and Agriculture Organization (FAO 1997) estimates that 75 percent of the world's crop genetic diversity has been lost since the turn of the century, and many of the high-yield crops species that are currently widely commercialized are often from a single cultivar and not adapted to "resource-poor" environments.

These two genetic issues confound one another: a potential decrease in native plant diversity and the ramped up production of commercialized cultivars has the potential to accelerate the decrease in overall plant genetic diversity for agricultural species. The narrowing of genetic diversity of agricultural crops may also have profound impacts on developing countries that rely on crop diversity for successful food production in often-marginal agricultural landscapes (FAO 1997; Rosset 2002). As these landscapes are converted to GE crop monocultures, crop rotation and genetic diversification are removed from the systems, turning them into "highly vulnerable agro-ecosystems dependant on high chemical inputs" (Altieri & Nicholls 2001, p. 122).

Population-Species Diversity

Attendant with the loss of allelic diversity amongst agricultural plants is a potential loss of frequency in heterozygosity at the population level, which oftentimes (although not always) confers fitness benefits, such as longevity and increased vegetative and reproductive output, and may enable adaptation to fluctuating environments (Ellstrand & Elam 1993). One of conservation biology's core principles is conservation of evolutionary potential (Meffe & Carroll 1997). Populations adapt to ecological changes, or deal with stochasticities, with genetic variability. Thus, if population variation is further decreased by accelerating the practice of monotypic agriculture via genetic engineering, conservation biologists have reason to be concerned about the long-term ability of crop species to adapt to environmental changes on an evolutionary timescale (or, the compressed timescale that may be necessary to adapt to the impacts of climate change).

Another, oft-cited problem at the population-species level is the potential for creating a weedy species through engineering a trait that changes the overall fitness (λ, or lambda) of the GEO, such as the target traits of salinity tolerance or herbicide resistance (Klinger, Elam & Ellstrand 1991; Meade & Mullins 2005; Snow et al. 2003). The field of conservation biology is ripe with examples of how weedy species can impact an ecosystem (Pimentel, Zuniga & Morrison 2005; Regal 1993), and practitioners ought to consider the potential consequences if agricultural GEOs themselves (or through gene flow, enable other species to) become weedy species. One recent mass effect model suggests that engineered crop species may pose substantial risks to wild-competing species, even if their "vital rates" (annual growth rate and escapee viability) show that they're less competitive than their wild relatives (Thompson, Thompson & Burgman 2003).

Community-Ecosystem Diversity

In the realm of scientific risk assessment for genetically engineered organisms, discussion of community and ecosystem impacts is commonly referred to as "non-target impacts." In pre-commercialization risk assessments for GEOs, these are the least-studied and understood ecological issues. However, it is at this level that conservation biologists might have the greatest number of concerns, and the greatest responsibility to help strengthen and enlighten risk analysis to ensure that threats to biological diversity are minimized.

One concern, discussed above, is how agricultural pests might impact agro-ecosystems and their surrounding natural ecosystems if they are released from existing population controls by developing resistance or tolerance. Weedy species have the potential to alter ecosystems in many fashions—compositionally, structurally, and functionally. It was after the Bt-monarch butterfly larvae issue, the subject of this research, that ecosystem ecologists and risk assessors started more seriously considering how agricultural GEOs might influence interactions at multiple trophic levels—from soil microbial communities and nutrient dynamics to higher trophic levels, such as arthropods and predatory invertebrates (Harwood & Obrycki 2006; Harwood, Samson & Obrycki 2006; Harwood, Wallin & Obrycki 2005). While these community and ecosystem interactions are of inherent interest to conservation biologists, they are especially so in threatened and endangered (T/E) ecosystems, or in those ecosystems where threatened and endangered species exist.

Consider, for example, areas of the world where rapid conversion of native vegetation to agriculture will also now include the planting of GE crops. Not only will that ecosystem be dealing with altered ecosystem function from the agricultural conversion, it will also be faced with a crop species whose non-target risks have almost certainly not been empirically tested within this broader ecological context. If a threatened or endangered species should also happen to inhabit that ecosystem, even small decreases in survivorship or the development of some kinds of sub-lethal impacts (e.g., decreased fecundity, prolonged age to maturity) that result from the GEO's ecosystem interaction could negatively impact the T/E species.

Although Ervin et al. (2003) have called for a more comprehensive kind of ecosystem-level GEO risk analysis that would include cumulative stresses, most non-target risk assessments to date address the impacts to only one species or family, and rarely, if ever, discuss broader community-ecosystem risks. If found in and around agro-ecosystems, pollinator insects (e.g., butterflies and bees) are evaluated for non-target impacts—usually increased mortality, but also sometimes sub-lethal and behavioral changes (Picard-Nizou et al, 1997; Pham-Delegue, Jouanin & Sandoz 2002). Cresswell and Osborne (2004) also tested whether patch size impacted GE gene flow in oilseed rape (*Brassica napus*) when bumblebees were the primary pollinator. When a species doesn't have a known critical function in an agro-ecosystem (such as providing a critical ecosystem service like pollination), however, the species is less likely to be evaluated for non-target impacts from GEOs. Such was the case with the monarch butterfly, whose GE risk assessment is described in detail in Chapter Two.

Landscape Diversity

The intensive agricultural settings of which GEOs are part have dramatically transformed landscapes, which is also of great concern to conservation biologists (Matson et al. 1997). Conservation biologists are concerned about how the arrangement, function and changes in landscape patches influence ecological processes. Intensive, monotypic agriculture has created fragmented landscapes, which decreases patch diversity and richness and the associated impacts on crop-pest complexes; soil biota and organic matter; and water and nutrient cycling (Thompson et al. 1997). One consequence has been a decrease in overall landscape diversity and connectedness between habitat types and metapopulations, which are usually needed to meaningfully conserve biological diversity. While Thompson's (1996) review of evolutionary biology considerations for biodiversity conservation doesn't specifically address GEOs, the article is instructive in highlighting several important landscape-level dynamics that conservation biologists will likely want to explore vis-à-vis risk assessment of GEO introductions: co-evolution in localized contexts; rapid evolution of surviving species following stochastic events; often unpredictable directionality of evolution; geographic dispersal within a metapopulation structure; evolution of resistance genes within a metapopulation structure; and possible impacts of hybrid zones on the landscape.

Even as genetic engineering promises to minimize the amount of natural lands converted to intensive agriculture by increasing yields on already-cultivated lands (Conko & Smith 1999), some are concerned that the ability of GEOs to thrive in circumstances outside of a species' natural range will result in the conversion of *more* wild lands into monotypic agriculture. Although not unique to GE crops (traditionally-bred crops could result in a similarly unfortunate loss of wild lands), such conversions to monotypic agriculture ultimately result in increased large-scale wildland fragmentation, and the rapid development of GE crops has the potential to accelerate those landscape-level changes (Altieri & Nicholls 2001). Others argue that the same factors that prevent diffusion of traditional crop improvements (subsistence-oriented economies without global market access) will likely mitigate widespread adoption of GE crops in marginal environments (Brush 2004). The recent enthusiasm for using corn to produce bioethanol, however, has particular potential for encouraging development of genetically engineered corn varieties that can grow where they previously did not, as well as to produce new GE corn varieties that facilitate conversion of stover to biofuels—such as reduced lignin content (Torney et al. 2007). Bioethanol is the driving factor for the increase in U.S. corn prices, which have risen from an average of about $1.70 per bushel in 2000-2001 to an average of $3.15 in 2006-2007, according to the National Agricultural Statistics Service (NASS). Further, if crop species can be engineered to more efficiently uptake limiting nutrients—a trait often touted as a promise for agricultural efficiency in marginal agricultural systems—large monotypic plantings of such crops have the potential to alter the functional diversity of landscapes as well, changing the rates of nutrient uptake and energy flux within systems. Madritch & Hunter (2002), for example, found that decreases in intra-specific genetic variation influenced carbon and nitrogen cycling in an oak sandhills community.

Multi-Disciplinary Approach

Given the above discussion, the field of Conservation Biology's mission to conserve evolutionary potential makes addressing the biodiversity threats from genetic engineering imperative. Clearly, a technology that promotes monotypic agriculture will ultimately narrow native and wild natural genetic diversity. This will be especially likely if the field of Conservation Biology is not actively engaged in the discussion and evaluation of these threats to biodiversity. Fortunately, conservation biologists were at the table to help write the first complete risk assessment framework for GEOs, which includes a systematic set of flow charts and worksheets to assess intended and unintended ecological effects and their potential secondary effects on human health and welfare (SWGB 1998). As Song & M'Gonigle (2001) correctly point out, conservation biology is uniquely aware, and positioned to grapple with, the problems with the uncertainties of scientific risk assessment and the broader social, economic and cultural contexts in which those uncertainties interact, because the field recognizes the "limitations of a reductionist approach to understanding complex systems" (p. 984).

In addition to protecting native biodiversity, the field of Conservation Biology is also cognizant of the notion of dynamic ecology. The ecology of living systems is not static, but dynamic—evolving as systems in equilibrium punctuated by dramatic changes and stochasticities that propel them onto different trajectories of ecological succession (Kingsland 1991; Song & M'Gonigle 2001). Again, this is another biodiversity value challenged by the development of GEOs, which genetic engineers usually design to thrive in (or meet the challenges of) specific static conditions, rather than for maximizing diversity and accomodating for evolutionary change in conditions.

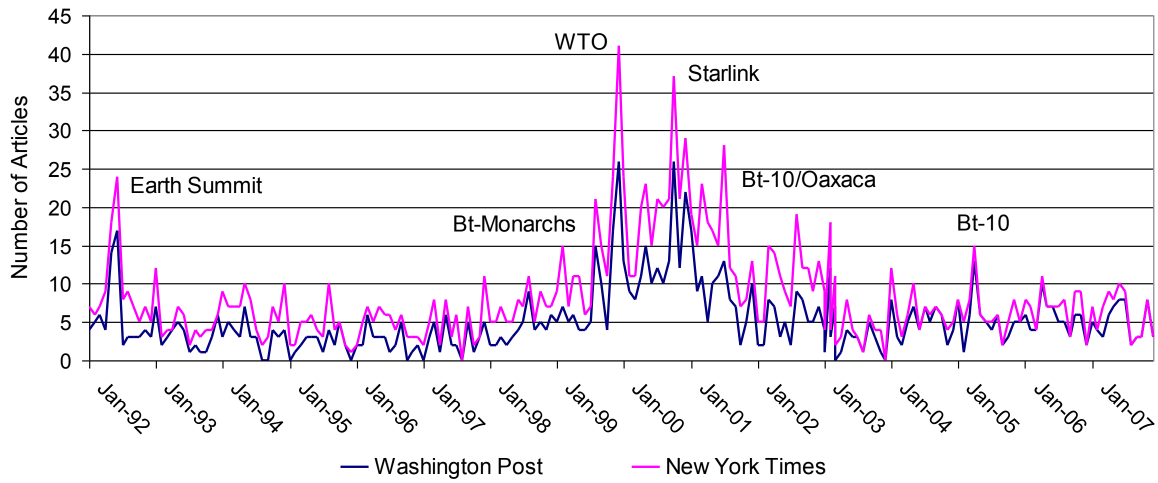
Finally, Conservation Biology is one of the only fields that explicitly deals with the human niche within ecosystems (and this species' unique economic, social and political systems) and takes on an advocacy role in conserving biodiversity when addressing human-nature relationships and conflicts. Because genetic engineering is a relatively new construct at the cutting edge of the human-nature divide, it is an area rich for exploring the value conflicts that exist between supporting a growing human population and protecting the native biodiversity—and subsistence cultural practices—that sustains it (McAfee 2003). In the global economy, for example, where developing countries must service increasing and unprecedented debt loads, international economic models promote growth based on large-scale export of agricultural products that fail to account for massive environmental degradation, including contamination, deforestation, erosion and loss of biodiversity (Altieri & Nicholls 2001; Nordhaus & Shellenberger 2007). A multidisciplinary approach to identifying, evaluating and mitigating the risks identified within these complicated, interwoven human-nature systems is clearly important, especially as modern agriculture—with genetic engineering at its fore—increases the pace of agricultural conversion (Burgmann 2005).

A particularly interesting place at which to start such exploration is at the point where the American public first began to grapple seriously with the potential risks to a native, non-target species from an agricultural GEO: the potential impacts of genetically engineered Bt (*Bacillus thuringiensis*) corn pollen on monarch butterfly larvae. A trend line analysis of coverage in the target newspapers, Figure 1.1, illustrates the major peaks in newspaper coverage of the potential ecological risks from GEOs in the *New York Times* and *Washington Post* from 1992 until 2007. The major news events during this period included the Earth Summit (June 1992); the World Trade Organization Protests and Cartagena Protocol negotiations (December 1999, January 2000); the discovery of the Starlink release into the food supply (October 2000); the controversy following the finding of Bt transgenes in Mexican landraces of maize (November 2001); and the finding that Bt-10 had been mistakenly planted in the United States (instead of Bt-11) and exported to Europe (March 2002, fines announced April 2005). As is evident in the trend line, the time period surrounding the finding that Bt corn pollen could impact monarch larvae (May 1999) through the re-issuance of the EPA permit to continue plantings of Bt corn (October 2001) saw the first marked and prolonged increase in the coverage of ecological risks from GEOs.

During this period, the monarch butterfly became a symbol of the “fragile ecology” that might be impacted by a bold, new agricultural technology. The species became a prominent symbol in numerous other GE-related news events during the time period as well, keeping the Bt-monarch “controversy” in the headlines and on the media agenda for 29 months. After Bt corn was “exonerated” from harming monarch butterflies in the fall of 2001, the case is mentioned only once in the *Washington Post* (2/23/05) and three times in the *New York Times* (8/17/03, 11/23/07, 12/26/07). The *New York Times* also reports twice on the potential for herbicide-tolerant crops to impact milkweed densities, the host plant for monarch larvae (3/14/05, 10/3/06).

How the ecological risks from Bt corn pollen were presented for debate in the public discourse influenced how those risks were socially constructed, as well as how the overall trajectory of GE discourse, policy and governance might progress into the future. Several key cognitive and cultural frames were employed to carry the story of the monarch butterfly forward, which are examined and deconstructed with this research effort.

Figure 1.1: Trend Line of *NYT* and *WP* Coverage of Ecological Risk and GEOs, By Month



Note: This trend line was created with a literature search in LexisNexis Academic Database using the Boolean search string: [gene!] PRE/3 [alter! OR modif! OR engineer!] AND [ecolog! OR environ!]. The search yielded 2,380 articles.

Case Study Background

Before moving on to a detailed analysis of the leading frames present in the opinion-leading coverage of the monarch butterfly larvae-Bt corn pollen (hereafter, the "Bt-monarch case"), it is useful to first understand broader context in which this case study was placed, the timeline of major newsworthy events that propelled the story forward, and the general flavor of the media coverage of the story. The remainder of this chapter does all of these things, with an eye for providing enough background information to develop the present analysis of media frames and the social construction of ecological risk. A complete chronology of the case study can be found in Chapter Three.

In May 1999, Cornell University researchers published a paper in the British journal, *Nature*, outlining their preliminary laboratory findings that Bt corn pollen could have a lethal impact on monarch butterfly larvae. The lead researcher, John Losey, an entomology professor at Cornell University, was prompted to study the impacts of Bt pollen on monarchs when he observed corn pollen coating milkweed leaves adjacent to agricultural test plots; milkweed is the only plant on which monarch larvae feed. His subsequent laboratory study found that survival for monarch larvae feeding on the Bt pollen-dusted milkweed was 56%, compared with 100% larval survival on milkweed not dusted with pollen or dusted with non-Bt pollen (Losey, Rayor & Carter 1999). While the American journal, *Science*, declined to publish the results of the research, *Nature* agreed to publish the study in its scientific correspondence section, where authors frequently publish preliminary research results. Both *Nature* and Cornell University sent out advance press releases to promote the article (Cornell University 1999; McInerney et al. 2004), and on May 20, 1999 the *New York Times* "broke" the story with its front-page article, "Altered Corn May Imperil Butterfly" by Carol Kaesuk Yoon. The story, which was below the fold and featured a photo of a fully-grown monarch perched on a flower, lead with a focus on how the research findings would be problematic for farmers and would fuel the debate about whether or not GE crops were safe for humans and the environment:

> All around the country, farmers are about to finish sowing millions of acres of a genetically altered form of corn that protects itself from pests by producing a toxin in its tissues. But researchers report today that this increasingly popular transgenic plant, thought to be harmless to non-pest insects, produces wind-borne pollen that can kill monarch butterflies -- a species that claims the Corn Belt as the heart of its breeding range.
>
> Researchers said the laboratory study, conducted by a team from Cornell University, provides the first evidence that pollen from a transgenic plant can harm non-pest species. So the study is likely to become part of the growing debate about whether genetically engineered crops may have unforeseen effects on the environment. (Yoon, 1A)

Hence began the news story that placed the potential ecological risks of genetically engineered organisms onto the American mass media agenda and forced the American public to begin grappling in earnest with the potential ecological consequences that might result from the whole-sale adoption of genetically engineered crops into world agriculture. The Bt-monarch story played out in the mass media over the course of 29 months, from the initial story in May 1999 until October 2001, when the National Academy of Science (NAS) published its scientific risk assessment for Bt pollen impacts on monarch larvae and the EPA renewed permits allowing the continued planting of Bt corn in the United States. Perhaps because the story had played itself out to a logical stopping point in the minds of American news editors, and perhaps because the nation became wholly focused on the events surrounding September 11, the Bt-monarch story faded from view in the mass media after the EPA "exonerated" Bt corn by deciding to reissue permits to plant the corn in the United States. While the media saw this as the natural stopping point for the story, the Bt-monarch case still lingers as a nagging question in the minds of some monarch butterfly and ecological risk researchers today (Jesse & Obrycki 2000, 2002, 2003, 2004; Oberhauser & Rivers 2003; Rosenthal 12/26/07).

The newspaper coverage of the Bt-monarch case can be characterized by four overlapping periods of emphasis (See Chapter Three for a more detailed description). The first period, from May 1999 until the late summer of 2000 emphasized the uncertainty of the scientific understanding about the ecological risks from Bt pollen on monarch larvae. This period is book-ended by the two major studies that raised concerns about lethal impacts to monarch larvae (Losey, Rayor & Carter 1999 and Jesse & Obrycki 2000) and includes within it the reporting of preliminary results of a massive risk assessment study coordinated by the NAS and funded by the United States Department of Agriculture (USDA) and the biotech industry's Agricultural Biotechnology Stewardship Working Group (ABSWG).

The second period of emphasis is one questioning the regulatory system for transgenic crops in the United States. This area of emphasis really began in August 1999, when Dr. Michael Phillips, who was directing an NAS study of ecological risks from GEOs, left NAS to work for the Biotechnology Industry Organization (BIO). The event cast a spotlight on the potential conflicts of interest that emerge when the scientists who are charged with regulating an industry (or in this case, charged with establishing scientifically credible decision analysis tools) also stand to profit from the development of a new technology. This second period of emphasis really continued right up to the perceived "end" of the controversy with the fall 2001 renewal of EPA permits to plant Bt corn in the United States. Other major events in this period of emphasis included the World Trade Organization protests in Seattle in December 1999 and several EPA public meetings and research findings, which some invariably questioned for their process or content.

The third period emphasized the clarification of scientific understanding of the risks to monarch larvae posed by Bt corn pollen. The risks began to be clearer with the presentation of preliminary research findings by the ABSWG in November 1999. The periodic release of emerging research results from various scientific studies were also reported during this period of emphasis, culminating in the publication of the massive risk assessment study in the Proceedings of the National Academy of Sciences (PNAS) in September 2001.

The fourth period of emphasis, a short but important one, was the exoneration of Bt corn pollen from monarch larvae mortality in the fall of 2001. The emphasis here was on the relative safety of Bt crops on non-target species based on the evidence presented by the NAS risk assessment study for monarch butterfly larvae.

Through these periods of emphasis, the mass media employed various frames to tell the story of the potential risks from genetically engineered crops on the charismatic monarch butterfly. The following section conceptualizes frames and framing research and explains the methodology for this research effort.

Framing: A Conceptual Model

Brief History of Framing Research

Framing research is a relatively new field of academic inquiry. The seminal book on the subject, *Frame Analysis: An Essay on the Organization of Experience*, was written in 1974 by social psychologist, Erving Goffman. Employing the metaphor of theater, Goffman's interest in frames stemmed from his broader research interest in how social actors are influenced by the conventions of the social performance (constrained and enabled *internally* by their individual roles in society, and *externally* by the rights and duties established by society) (as described by Albrow 1999). Frames described, "how people rely on expectations to make sense of their everyday social experience," (Reese 2001, p. 7).

Because framing research had multi-disciplinary appeal to the fields of communication studies, sociology and political science, it began to be explored as a potential form of media critique. It was likely Todd Gitlin's (1980) book, *The Whole World is Watching: Mass Media in the Making & Unmaking of the New Left*, that launched the more serious effort to pursue framing as a methodology for mass media research. Today, media researchers use framing research to explore questions about the interplay between media practices, culture, ideology, audiences, and producers. This research is based on the central assumption that the symbols and frames used by the mass media are representative of (or, say something about) the broader social constructions of reality. As a research methodology, framing has most commonly been used to try to understand the media's role in political life (Reese, 2001). However, more media researchers are now also using media framing as a "substitute symbolic site for public debate activity rather than simply a source of fuel for it or of information reports about it" (Priest, 1999, p. 99; Gumpert & Drucker, 1994). As such, framing has recently emerged as an approach to examining how mass media frames can influence science-related public policy (Nelkin 1995; Allgaier & Holliman 2006) and the mobilization of social movements (Zavestoski et al. 2004).

Scholarly Turf War (& Definitional Opportunity)

Perhaps because the media interest in framing research stemmed from an interest in the mass media's role in political life, a debate has arisen amongst communication, mass media, and political communication scholars about whether framing research is merely some kind of an extension of agenda-setting research, or is rather a methodology or research paradigm onto itself (see McCombs & Ghanem 2001; Maher 2001). The debate has helped to further define frames, especially in terms of scale. In the broadest conceptualization, framing is more than a research methodology—it is a grand theory of communication research that can help define all other communication research efforts. In a slightly narrower conception, it is conceived of as an emerging, separate (but slightly overlapping) paradigm to agenda-setting research. In its narrowest conception, it is a subset of agenda-setting research—the so-called, "second level" of agenda setting.

In terms of a grand theory, Entman (1993) sees a clarified definition and theory of framing as a potential paradigm to guide future communication research. As part of this grand vision, Entman suggests that the framing paradigm is fertile ground on which multi-disciplinary study can thrive. According to Entman,

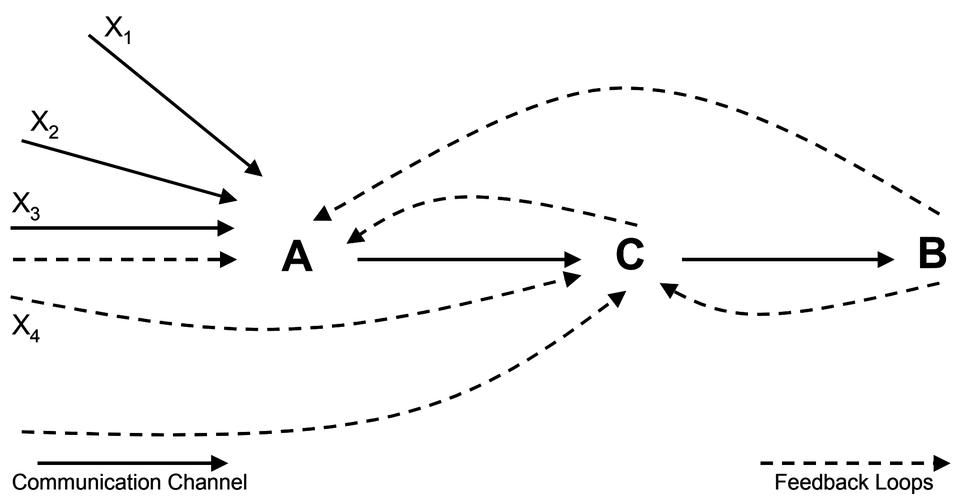
> By bringing ideas together in one location, communication can aspire to become a master discipline that synthesizes related theories and concepts and exposes them to the most rigorous, comprehensive statement and exploration. Reaching this goal would require a more self-conscious determination by communication scholars to plumb other fields and feed back their studies to outside researchers. At the same time, such an enterprise would enhance the theoretical rigor of communication scholarship proper (1993, p. 51).

Maher (2001) sees framing and agenda-setting research as having historically opposite trajectories, and therefore views them as separate paradigms. He argues that agenda-setting research has lacked theoretical depth, but has given communication research valuable tools for measurement (especially in the realm of media effects). By contrast, Maher views framing research as rich in its theoretical underpinnings (especially with its roots in social psychology), but an "elusive concept to measure" (p. 84). Maher sees a significant conceptual rift in how agenda-setting and framing researchers conceptualize the source of frames. He argues that agenda-setting researchers proceed under the assumption that a frame is one of many kinds of attributes of the subject that researchers can examine to determine if a correlation exists between the media's "attribute agenda" (e.g., a political candidate framed as "honest") and the public understanding of the subject. By contrast, Maher argues, framing research emphasizes the "constructed nature of media messages" and focuses on how the frames in these messages lead to some insights about how the journalists construct the issue. "These framing decisions," he argues, "provide important evidence about the flow of power in society" (p. 88).

As suggested by the above discussion, McCombs & Ghanem (2001) envision framing as a sub-discipline of agenda-setting research. Specifically, these authors see framing as an element of attribute framing, or the "second level" of agenda setting. Agenda setting, as defined by a leading scholar in the research paradigm Maxwell McCombs, is the transference of issue salience from the mass media to its audiences. Over the past few decades, agenda-setting research has evolved into two levels. The first level examines how object salience is transferred between media and audiences (i.e., how successful are the media at influencing *what* the audience thinks about?). The second level of agenda-setting research examines how attribute salience is transferred (i.e., how successful are the media at influencing *how* the audience thinks about a subject matter?). McCombs and Ghanem argue that viewing frames within the realm of second-level agenda setting allows researchers to sort out the many different kinds of frames that exist—among them, cognitive, affective, micro, macro, aspect, and central.

Like any good academic "turf war," this one is still probably years from any kind of resolution. However, the debate itself provides some insights into the definition of frames, and must be considered by researchers endeavoring to study mass media frames. In terms of its position within this larger scholarly debate, this research really proceeds from an understanding of framing research as a separate paradigm from agenda-setting research for two reasons. First, as is made clear in the definition of this research question (below, p. 29), this research is focused on the first two parts of the research communication model—on the system of production and the products (Figure 1.2). If framing is conceptualized as subsumed by attribute agenda setting, the focus would be on the transfer of salience from the media to their audiences (or, the social effects part of the communication process model). Second, because I am ultimately interested in gaining some insights about mass media frames that represent and influence the social construction of ecological risk, the starting point of this research is, as Maher puts it, the "constructed nature of media messages." The focus of this research is on the ways in which the media represent reality, as a selective, highly-mediated process that begins with which stories are chosen for telling and how information subsidies are used to construct that story (Allgaier & Holliman 2006).

Figure 1.2: Westley & MacLean (1957) Model of Mass Communication Process



Note: From Shoemaker & Reese 1991. "A" represents the communicator; "C," the mass media channel; "B," the public; "X_i," the universe of possible messages. Curved, dashed lines represent feedback loops from each part of the communication process. The message that is ultimately selected for transmission is influenced by a hierarchy of influences on the communicator and communication channel from the individual, media routines, organizational, extramedia and ideological levels.

Toward a Concise Definition of a Frame

As should be evident by the above discussion, because framing research is still an evolving academic field, framing definitions and theory are still relatively fluid. It was only in 2001 that a serious attempt was made to compile a written collection of framing research in mass communications and begin to tease out the emerging theoretical underpinnings of this vein of social science research. The collection, edited by Reese, Gandy, & Grant (2001), was the result of an October 1997 conference on the subject, "Framing in the New Media Landscape." It was in this collection that researchers really tried to synthesize two decades of framing research in mass communications, distill a comprehensive definition of frames, and summarize the status of theory development. The effort was a long-overdue answer to Robert Entman's (1993) often-cited critique of the methodology's lack of academic rigor and "scattered conceptualization."

The working definition proposed in the prologue of the Reese, Gandy, & Grant collection involved six key components (in bold here):

> Frames are ***organizing principles*** that are socially ***shared*** and ***persistent*** over time, that work ***symbolically*** to meaningfully ***structure*** the social world (Reese, 2001, p. 11).
>
> Reese breaks down each key component to succinctly define a frame:

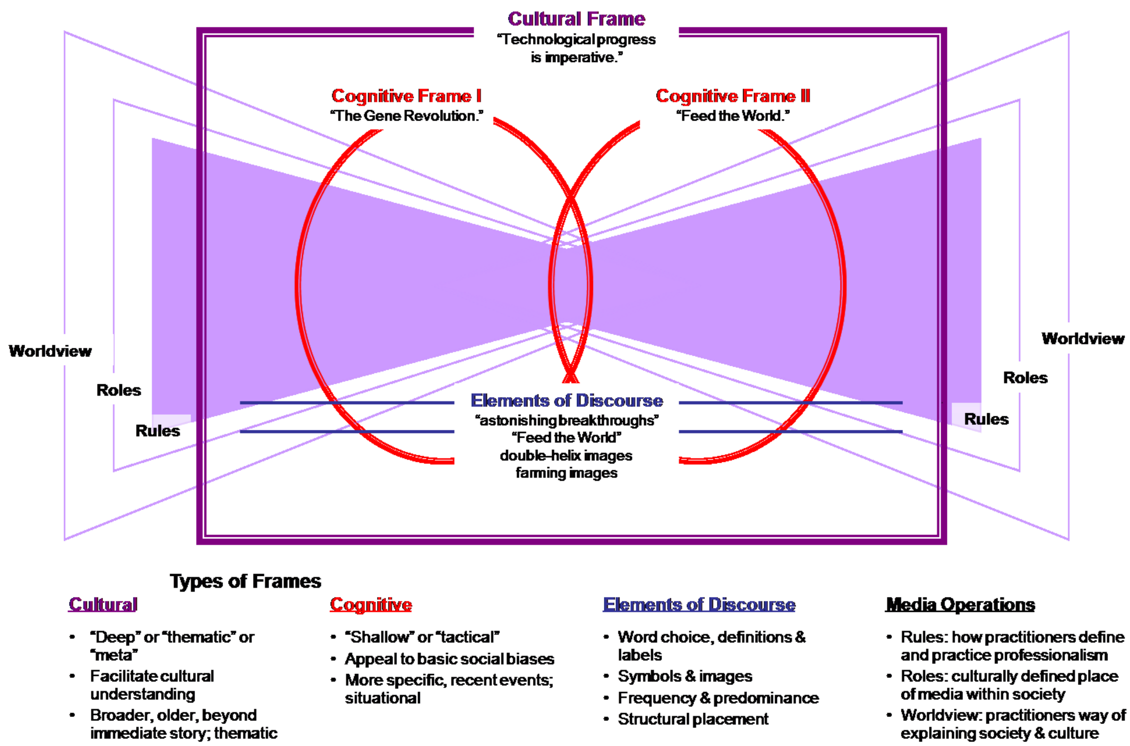
1. Frames *organize* information to generate meaning through inclusion, exclusion, and emphasis of certain information.

2. Frames are based on *principles* ("interlocking and competing organizing ideas") from the larger social structure (i.e., they build on social and cultural values).
3. Frames must be *shared* to be communicable, embraced and produce "negotiated meaning."
4. Frames are routinely used over time and across issues (*persistent*).
5. Frames are revealed through *symbolic* devices (e.g., adjectives, phrases, metaphors, images), and may be implicit in the messages or images rather than explicitly stated.
6. Frames provide identifiable *structures* or patterns, so they don't have to be initiated anew with every message (they are built upon over time through socially explicit patterns).

Types of Frames & Conceptual Model

Building from this operational definition of frames, two broad categories of frames emerge from the literature (although the terms used to describe them vary amongst authors), which were developed into the conceptual model that this research uses to investigate the framing of ecological risks in the Bt-monarch case (See Figure 1.3).

Figure 1.3: A Conceptual Model of Frames & Framing



Note: These elements of cultural and cognitive frames emerge from contributed chapters in Reese, Gandy, and Grant (2001). The conceptual model was inspired by Altheide (1996).

Broadly, this conceptual model proposes two kinds of frames, cultural and cognitive (although they are labeled and defined variously throughout the literature, Reese settles on the terms "cognitive" and "cultural"). *Cultural frames* are the broader of the two types of frames, and are labeled by various scholars as deep frames, strategic frames, thematic frames, and even meta-frames (or meta-narratives). These frames are enduring frames that transcend the immediate issue, event, or media story. They are called cultural frames because they help facilitate deeper thematic understanding and provide broad context to the immediate information being processed (Reese 2001). For example, in the case of GEOs, stories might fall within a broader cultural notion (although perhaps never explicitly stated) that technological progress is an imperative for an advanced society. Additionally, Tammpuu (2004) and others argue that social acceptance of new genetic technologies is also largely embedded in these broader cultural values and symbolic frameworks.

Cognitive frames, on the other hand, are more narrowly focused, and also referred to in the literature as shallow frames, tactical frames, or situational frames. These frames are transient, based on the situation or event, and are specific to messages about the present issue (Reese 2001). These frames appeal to the basic social biases in society. In the case of GEOs, for example, a cognitive frame might be the notion of the "gene revolution" (situation-specific frame for the current time) as the logical evolution of the "green revolution" (a situation-specific frame for a previous time) in the technological evolution of agriculture.

Both kinds of frames are constrained and enabled internally by the symbols, images and elements of discourse used by stakeholders, and externally by the connections to sources of information, the socially agreed-upon "rules" and structural elements of mass media, professionalism and the role of this institution in a democratic society. Ideology and worldview can influence frames internally and externally.

Central Research Question & Objectives

Social Construction of Risk

Even within the scientific literature about ecological risk assessment for GEOs, authors express concern over how the public perceives these novel new agricultural crops. For example, Connor, Glare & Nap (2003) lament the impact of public opinion amidst the backdrop of serious global food and nutrition security,

> The public concern is becoming increasingly more vocal and sometimes violent. In Europe (and New Zealand), consumer acceptance of commercial gene technology products seems further away than ever. Consumers in the U.S. are awakening to the controversy…and regulators follow…The coming years may, therefore, prove decisive for the commercial and economically viable application of GM crops in agriculture and food production. Without the consent of society at large, GM crops will fail in the marketplace. (p. 20)

Conner, Glare & Nap (2003) go so far as to suggest that the relevant scientific questions about the safety of GEOs have been repeatedly asked and answered over the past 15 years to the dissatisfaction of the general public. They opine that this overall dissatisfaction may reflect broader public concerns over "the changing nature of agriculture at large," which are value-based and philosophical and unlikely to be changed by scientific risk assessments.

Those public concerns are also increasingly likely to be the product of *mediated* knowledge, not of lived experience, because most people are not directly involved with scientific research (Tammpuu 2004). Priest (1999) compares media consumers' evaluation of biotechnology information to that of a consumer buying a used car.

Without direct experience with the technology, the public must rely on competing perspectives of the previous owners—and their motivations for selling—to ascertain whether or not to buy (and buy into) this new-to-you technology, oftentimes in the face of little technological literacy on the consumer side of the transaction.

Today, a majority of the human population is already living in urban environments, detached from both the systems of food production and the natural world. According to the United Nations Population Fund, more than 60% of the world's population will live urban areas by 2025, and some 75% of people from more-developed regions already live in urban settings (United Nations, 1995). As a result, many of society's notions about ecological risk are formed—not from direct exposure to agro-ecosystems—but secondhand, through mass media and electronic information channels. A central premise of this research is that the U.S. mass media comprise a *central* social and cultural institution by which the general population derives its understanding of issues for which it does not have direct experience or expertise. As such, mass media outlets function—actively and passively—as agents of definition, revision, inclusion, and exclusion of the central tenets of risk. In other words, the mass media play an active role in socially constructing risk for most Americans by selecting the elements of discourse used to frame the debate about new technologies, such as genetic engineering (Andree 2002; Priest 1999; Schenk & Sonj 2000; Tammpuu 2004). In the Bt-monarch case, the media played an important role in framing the ecological risk issues for a wider audience and in mobilizing different actors to engage in further risk assessment. Thus, the media became the major channel for representing arguments in the ongoing debate over public policy regarding GE crops (Allgaier & Holliman, 2006).

Research Question & Objectives

It is within this broader social and cultural context, where the mass media actively frame and construct the elements of discourse to define ecological risk that this research endeavors to answer the following central question:

> ***How did the U.S. mass media frame the potential ecological risks from genetically engineered organisms for the general public in the Bt-monarch controversy?***

In an effort to address this question, I set forth with two research objectives:

1) To define the cognitive and cultural frames used by the mass media and stakeholders associated with the ecological risks of genetically engineered organisms by examining written documents from the monarch/Bt corn case (Chapters Three and Four).

2) To use the lessons learned from this research to recommend ways conservation biologists might use frame analysis to uncover key cognitive and cultural frames that influence the social construction of risk to better inform their public outreach and education efforts.

Research Design & Methodology

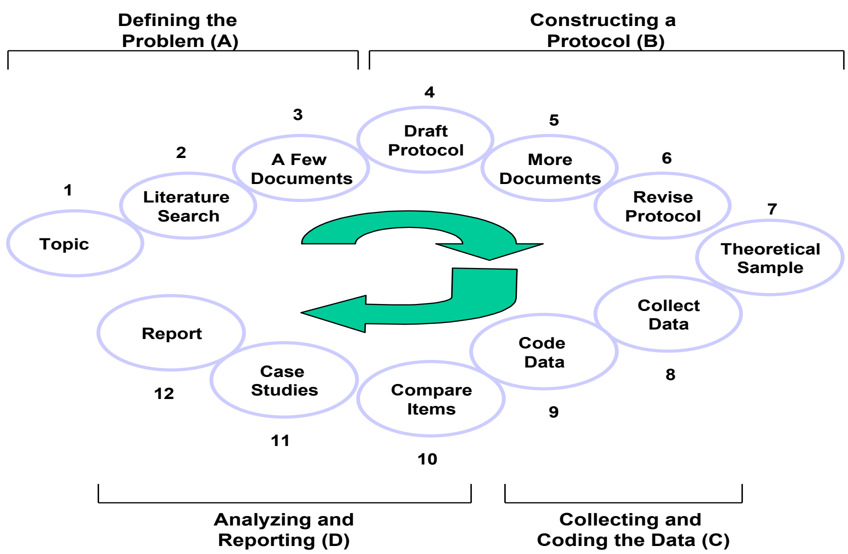
Reflexive Research Design

This research used a reflexive, grounded theory research design that was adapted from Altheide (1996) and Strauss & Corbin (1998). Altheide diagrams and describes a twelve-step process for conducting qualitative media research (Figure 1.4) in a way that is very complimentary to Strauss & Corbin's description of grounded theory as a circular process, "one that involves a lot of going back and forth and around before finally reaching one's goal" (Strauss & Corbin (1998). Altheide's 12-step process can be easily broken down for descriptive purposes into four phases: A) Defining the problem (steps 1-3); B) Constructing a protocol (steps 4-7); C) Collecting and coding the data (steps 8-9); and D) Analyzing and reporting the data (steps 10-12).

Phase A: Defining the Problem

In describing the process of framing research, Stuart Hall describes this phase of the research process as one in which the researcher takes "a long preliminary soak" in the materials in order to decide what research approach will best address the research question (as cited in Gitlin, 1980). During this stage of the research process, the researcher identifies which parts of the research question will best be answered by quantitative analyses, and which will be best addressed by the more-nuanced, qualitative analyses. Several authors suggest that the best of ethnographic content analyses will combine both quantitative and qualitative analyses of documents (Altheide 1997; Gitlin 1980; Hertog & McLeod 2001; Ryan & Bernard 2000). During this "preliminary soak," the researcher defines the specific research question (step 1), identifies possible sources of information (step 2), and becomes familiar with several examples of relevant documents in order to determine a preliminary unit of analysis (step 3).

Figure 1.4: Altheide's 12-Step Process of Qualitative Document Analysis



Source: Altheide, 1996, p. 13.

Note: For descriptive purposes, this research divided Altheide's model into four research phases: A) Defining the problem (steps 1-3); B) Constructing a protocol (steps 3-7); C) Collecting and coding the data (steps 8-9); and D) Analyzing and reporting the data (steps 10-12).

During Phase A, the research question and objectives were identified and an initial set of 42 documents from the *New York Times (NYT)* and *Washington Post (WP)* were located using the search string, [gene!] PRE/3 [alter! OR modif! OR engineer!] AND [monarch], in the LexisNexis Academic Database. The search was limited to the years between 1998 and 2002 (See Appendix B for a complete list of articles). The articles were imported into the content analysis software package, NVivo 2.0.163, to aid in analysis. The research process began with analysis of the original 42 articles. During the initial reading, media articles were coded in random order, so the learning that occurred throughout the research process would not be focused on one time period of the story development versus another. Subsequent readings and analysis of articles followed promising research threads and questions that evolved during the course of study.

Phase B: Research Protocol

Using the initial sampling of media documents, I followed Altheide's suggestion to begin construction of the protocol by listing several items or categories (variables) to guide data collection. To start, sources used by the media (an initial step in defining stakeholders) and obvious discursive elements (an early effort to organize information that might uncover cognitive frames) were coded. The coding was reflexive, starting with a few elements and recoding documents as new discursive elements emerged.

For qualitative document analysis, Glaser & Strauss suggest that a "theoretical sample" be drawn in order to maximize the researcher's ability to "capture the meanings, emphasis, and themes of messages and to understand the organization and process of how they are presented" (as paraphrased in Altheide, 1997, p. 33). Rather than being pre-determined at the outset of the research, theoretical sampling evolves during the research process based on emerging threads or noticeable absences in an initial set of documents (Strauss & Corbin 1998). In the present research, the theoretical sampling was initiated with a subset of the media documents. The sample was expanded to include the core 42 media article documents, and became inclusive of additional popular press, scholarly, and governmental documents and literature as I followed research leads and discursive threads along the way. I tracked the inclusion of different documents for analysis and the development of frames from different discursive threads by writing memos throughout the research process. *Other stakeholder texts* were identified later in the research process and included press releases; Web site content; position papers; public comments on policy initiatives; newsletters and editorial comments; and advertising copy. Review of stakeholder texts varied depending on access and availability.

Phase C: Collecting and Coding the Data

The process of collecting data in a reflexive research approach requires that the researcher continually revise and re-evaluate the coding nodes as the research progresses to permit emergence, refinement, and collapsing of data categories. Once these adjustments are made, the previously coded materials must be re-coded. This is necessary, according to Altheide, because as the researcher becomes more familiar with his/her subject matter, the categories and codes become more precise.

During multiple readings of the case study documents, coded elements were arranged into nodes and sub-nodes that meaningfully described the content of the media articles. Nodes were then reviewed and described in the process of writing the research findings.

Phase D: Analyzing and Reporting the Data

In the final phase of the research process described by Altheide, the data collected are first analyzed for connections, comparison/contrast of "extremes," and key differences within categories and items. Summaries are then generated from the analysis of each category. Once summaries are complete, the researcher selects appropriate examples (or case studies) from the sample to illustrate each of the major points in the findings. Finally, ideally the research is reported in such a way that contextualizes the findings into meaningful ethnographic analysis. Toward this end, Altheide notes that the ultimate goal of the final report is to,

> "understand the process and character of social life and to arrive at meaning and process; we seek to understand types, characteristics, and organizational aspects of the documents as social products in their own right, as well as what they claim to represent" (1997, p. 42)

For the present research, the summary of research findings (Chapter Three) led to the initial diagram of cognitive and cultural frames that constructed ecological risk for the Bt-monarch case. The research process became once again reflective with additional analysis of supporting documents (Appendix C) as the cognitive and cultural frames emerged. The supporting documents were used to triangulate the research and revise cognitive and cultural frames as new evidence was located.

Timeframe: May 1999-October 2001

The focus of this research is the Bt-monarch case study, which appeared in media coverage beginning with the Losey, Rayor & Carter study (1999) and ending with the EPA renewal of Bt corn permits in October 2001. The theoretical sample pursues further media documents outside this timeframe as is necessary to develop a rich analysis of media frames. This further exploration of media messages is limited, however, to the years 1992-1997. Although a relatively small group of concerned scientists were talking about the ecological risks from GEOs throughout the 1980s, it was the 1992 Convention on Biological Diversity (CBD) that pushed biotechnology onto the issue agenda in the conservation community. Articles 16 and 19 of the CBD include a directive to encourage the development of biotechnology as a conservation tool. Almost immediately following the signing of the CBD, ecologists and indigenous peoples raised several important concerns about the inclusion of biotechnology in this document; however, it was eight years until these concerns were formalized into a protocol that would amend the Convention and seek to approach biotechnology by means of a precautionary principle (Cartagena Protocol in 2000).

Newspapers: *The New York Times* and *Washington Post*

The New York Times (NYT) and *The Washington Post* (*WP)* are widely considered two of the "opinion-leading" or "elite" newspapers in the United States and are nearly always recognized on lists of leading U.S. newspapers (Gans 2004; Shoemaker & Reese 1991; Ten Eyck, Thompson & Priest 2001). That is, the *NYT* and *WP* (in addition to the *Wall Street Journal*, which was unavailable for search via LexisNexis Academic Database) have been shown to shape the media agenda across the United States. These key newspapers drive the editorial content of print and television news organizations nationwide, with other leading regional and local newspapers oftentimes following up with localized angles on topics defined as important by these newspapers. Criteria of opinion-leading papers include a large readership, particularly amongst other journalists, strong connections with other power centers ("elite universities" and Fortune 500 companies) and consideration as one of a nation's "papers of record" (Bauer 2007; McChesney 1999; Shoemaker & Reese 1991).

Opinion-leading newspapers are appropriate for investigating how frames shape the social definition of ecological risks from GEOs. The *New York Times* and *Washington Post* can be viewed as benchmarks for how other newspapers, and television news programs, will cover a story. According to Gans (2004)

> …Journalists seem to need a more general standard setter; and that role is played, both in television and at the magazines, by *The New York Times* and, to a lesser extent, by the *Washington Post*…When editors and producers are uncertain about a selection decision, they will check whether, where, and how the *Times* has covered the story; and story selectors see to it that many of the *Times'*s front-page stories find their way into television programs and magazines. (p. 180)

With a circulation of 1.1 million weekdays and 1.7 million on Sunday, *The New York Times* has a reputation for being the "newspaper of record" in the United States (Gans 2004; Shoemaker & Reese 1991). The newspaper's reputation as an "independent" stems from its historical ownership structure, which distributed voting rights amongst the Sulzberger family and buffered its management from "pressures from outside stockholders and threats of corporate takeovers" (Shoemaker & Reese 1991).

Based primarily on its leading role in breaking the story on Watergate, *The Washington Post* has developed a reputation for being a "hard-hitting" investigative reporter of government policies and Washington politics. Its circulation of 782,000 weekdays and 1.1 million on Sunday are numbers that include most of the Washington elite: members of Congress and the Executive Branch, foreign dignitaries and diplomats, political lobbyists and corporate lawyers living in the Washington D.C. area.

Key Assumptions

There are several key assumptions to this research and methodology that should be made explicit. The largest is the assumption that the way journalists choose to frame ecological risks and social benefits is somehow representative of the larger (U.S.) social construction of ecological risk. This assumption is based on previous research that suggests that the mass media play a significant role in bringing salience to issues that previously were ignored or low on the public agenda (Gans 2004; McChesney 1999; Shoemaker & Reese 1991).

A second, related, assumption is that the *NYT* and *WP* are representative of other news coverage of this issue (and hence, can be used as a barometer for wider cognitive and cultural frames). This assumption is based on broad acknowledgement of these two newspapers as "opinion leaders" and "papers of record" in the United States.

Finally, this research assumes that, even within the context of this electronic media era, analyzing print coverage still says something meaningful about broader social understanding and construction of ecological risk. Of course, this assumption is challenged more and more every day as the U.S. citizenry now connects, via the Internet, to a broader array of alternative and international information sources. Because much of this case study took place before the popularity of Internet Web logs (“blogs”), this research assumes that most of the general public learned of the Bt-monarch case from newspapers or other mass media influenced by opinion-leading media agendas (e.g., television news programs and documentaries).

CHAPTER TWO

Ecological Risks from Transgenic Crops

Chapter Contents

We delight in the beauty of the butterfly, but rarely admit the changes it has gone through to achieve its beauty.

(Maya Angelou)

The goal of this chapter is to provide a broad overview of the current understanding of ecological risks from genetically engineered organisms, with a specific focus on the risks of one GEO, Bt corn, to one non-target species, the monarch butterfly (*Danaus plexippus*). While genetic engineering research is now being pursued in varying degrees throughout many different taxa, this discussion will be limited to transgenic agricultural crops, as it is within the context of these types of GEOs that the present research case study evolved. Genetically engineered plants make up the vast majority of GE research—comprising 98% of all field test permits issued and recorded by the Organisation for Economic Co-operation and Development (OECD) (Nap et al. 2003). This chapter contextualizes this research within the broader discussion of ecological risks from GEOs and is not meant to be a comprehensive treatment of ecological risks from transgenic insecticidal crops. Such research is now the length of books, not a single dissertation chapter (see for example, Glare & O'Callaghan 2000; NRC 2002; or Scientists' Working Group on Biosafety 1998); shorter reviews also appear in many ecology journals, such as O'Callaghan et al. 2005; Sharma & Ortiz 2000; Pilson & Prendeville 2004; Snow et al. 2005; Wolfenbarger & Phifer 2000).

GE Crops: Products, Pipeline, and Promises

New molecular technologies have allowed the transfer of genetic material across species boundaries. Transgenic crops are those that have been infused with genetic material from other species—plant, animal, or microbe—in order to confer new traits to improve crop performance (e.g., resistance to pests, diseases, herbicides, or environmental stresses), quality (e.g., improved flavor, nutritional content), or for use in non-traditional applications (e.g., the production of manufacturing or pharmaceutical compounds) (Nap et al. 2003; Sharma & Ortiz 2000). Genes are most commonly removed from one organism and placed into the genome of another using the bacterium, *Agrobacterium tumefaciens,* as a vector agent or by using a DNA-coated microprojectile to transfer the genetic material (Wrubel, Krimsky & Wetzler 1992). Whereas conventional breeding techniques use genetic manipulation via crosses of sexually compatible plants to select for desirable traits, genetic engineering selects for the desirable trait by identifying discrete genetic units that express the trait, and transferring them directly into another organism, which doesn't necessarily need to be sexually compatible. While some characterize this process as more precise than conventional breeding techniques, some uncertainty still exists with GE due to the random position of the insertion site of the new genetic material, as well as the unpredictability of proteins that may be expressed as a result of such insertions (Bucchini & Goldman 2002).

According to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), planting of all types of genetically engineered crops has risen steadily over the past decade, more than doubling since the time of the Bt-monarch case study, to a recent high of 114.3 million hectares (282.4 million acres) across 23 countries in 2007 (James 2007). This compares with 44.2 million hectares, or 109.2 million acres, in 13 countries in 2000. In the United States, 57.7 million hectares (142.6 million acres) were planted in 2007, vs. 30.3 million hectares (74.9 million acres) in 2000 (James 2007, 2000). ISAAA reported that 71% of the total acreage of dominant GE crops (soybean, corn, cotton, and oilseed rape) planted worldwide in 2001 contained an herbicide resistance trait; 18% contained an insect resistance trait (Bt); and 11% contained stacked herbicide- and insect-resistance traits (James 2005).

In terms of genetically engineered corn, the subject of this research, nearly a quarter (35.2 million hectares, or 87.0 million acres) of all corn planted throughout the world is now genetically engineered (James 2007). That percentage has risen steadily (but slowly) since 2003, following a brief period of decrease in 2000-2001, corresponding to the Bt-monarch case study timeframe. Sixty-three percent of all GE corn planted in the United States in 2007 was from "stacked trait" varieties (James 2007).

Whether these plantings continue to increase globally is dependent on the economic benefit of the transgenic trait to farmers. An often-cited impetus for GE crops currently on the market—primarily insect-resistant and herbicide-tolerant (HT) varieties—is the potential reduction of pesticides and herbicides and the correspondent benefits to the environment and human health (Borlaug 2000; James 2007, Meade & Mullins 2005). Some cite the rapid adoption of GE crop varieties as evidence of their effectiveness in these regards (Betz, Hammond & Fuchs 2000; James 2007); however, the realized economic gains from planting GE crops vary considerably by location and context (Meade & Mullins 2005). A model by Zhou & Kastenberg (2006) also quantified the change in synthetic chemical pesticide exposure to humans and discovered unpredicted patterns in U.S. populations, including increased exposure to non-farm populations through groundwater transport. The authors also found increased use of and exposure to trifluralin and glyphosate since the introduction of HT soybeans between 1996 and 2000. And, while some researchers have documented decreases in insecticide use since the release of Bt corn and cotton in the United States and China (Benbrook 2004; Pilson & Prendeville 2004), others suggest that Bt corn has had little impact on insecticide use in corn crops, since farmers have not typically used insecticides for corn borers (Mellon & Rissler 2003). Fernandez-Cornejo & McBride (2002) also point out that while HT soybeans have decreased herbicide acre-treatments in the United States, they have also reportedly increased the overall amount of herbicides applied, because glyphosate requires higher doses than the herbicides it replaced (as cited in Mellon & Rissler 2003).

GE *Bacillus thuringiensis* (Bt): Background, Benefits, and Risks

Although other forms of GE insect resistance are being explored, transgenic Bt is the most widely applied of the plant-incorporated protectants (for a description of others, see Gatehouse et al. 1993 or O'Callaghan et al. 2005). Microbial *Bacillus thuringiensis*-based insecticidal products have been available commercially since the 1960s, and are a preferred form of "natural" insect control by organic farmers. Bt is a ubiquitous and naturally occurring soil bacterium that forms crystalline endotoxins ("Cry proteins") that are toxic in a variety of insect pests due to the site-specific binding of Cry proteins to the mid-gut cells of susceptible insects, which ultimately causes these cells to burst (Betz, Hammond & Fuchs 2000). Commercially available since 1996, Bt-protected plants have been genetically engineered to express these toxins in plant tissues, eliminating the need for broad application in sprays on agricultural fields. Thousands of Bt strains have been identified worldwide, and genes have been identified for some 170 specific endotoxins, providing a diverse source of Cry proteins for potential use in agricultural applications (Glare & O'Callaghan 2000).

The rationale for developing Bt-protected plants is the annual billion-dollar price tag for damage from agricultural pests, as well as the decreased effectiveness of some existing synthetic pest control methods due to insect resistance (Hyde et al. 2001). The appeal of Bt over other potential insect-resistant GE methods is that researchers in the mid-1980s found that Bt toxins were encoded by single genes (Glare & O'Callaghan 2000). While Bt was originally thought to be specific to Lepidoptera, continued research has now discovered Bt strains that are toxic to more than 16 orders (and 3,000-plus pest species) of insects. However, each strain of Bt appears to demonstrate a certain level of specificity, making Bt a candidate for continued development as a pest management strategy (Glare & O'Callaghan 2000). For example, Cry1Ab, Cry1Ac, Cry1F, and Cry9C have been found toxic to moth larvae, whereas Cry3A and Cry3C have been toxic to beetles and their larvae (Snow et al. 2005). In addition to lethal impacts, the different Cry proteins of Bt are also known to cause several sub-lethal effects, especially in Lepidoptera, including delayed or retarded development; reduced larval and pupal weight and size; decreases in pupation and adult emergence and lifespan; losses in adult fecundity; reduced egg viability; and changes in feeding behavior (Glare & O'Callaghan 2000).

The currently commercialized forms of Bt corn express toxins in their plant tissues that are intended to control two Lepidopteran pests—the European corn borer (ECB, *Ostrinia nubilalis*) and the Southwestern corn borer (SWCB, *Diatraea grandiosella*) (Benbrook 2001). However, Vandenberg & Van Wyk (2007) recently discovered that the toxin expressed in the MON810 Bt corn event (Cry1Ab) was also toxic to a South African Stem borer, *Sesamia calamistis*. By the year 2005, 16 percent of all GE crops planted worldwide were Bt corn; eight percent were Bt cotton; and more than 16 million hectares (39.5 million acres) of Bt crops were planted worldwide (James 2006, 2005). A combination (or "stacked") GE crop of Bt and HT corn was planted on some 2.6 million hectares (6.5 million acres) in 2005, up 72 percent from the 1.5 million hectares (3.8 million acres) in 2004, and is considered a trend that "will intensify as more traits become available to farmers" (James 2005, p. 36). According to Nap et al. (2003), research on Bt-mediated insect resistance is also in advanced stages in rice, tobacco, potato, eggplant, cauliflower, cabbage, and pigeon pea—suggesting that commercial varieties of these agricultural products may be on the near horizon.

Ecological Risks of Bt in Agro-Ecosystems

Background

Several reviews now outline of the ecological risks from genetically engineered insect-resistant crops (Dale, Clark & Fontes 2002; Fontes et al. 2002; Snow et al. 2005). The following is intended to be a short review of these impacts, with a broader focus on the literature that addresses impacts to non-target organisms (see also Oberhauser & Rivers 2003). Particular attention will be given here to transgenic Bt corn, which is the subject of this research inquiry. The most comprehensive reviews regarding the environmental concerns about Bt plant-incorporated protectants (PIP) are the EPA's (2001) Biopesticides Registration Action Document (BRAD) and a review by Glare & O'Callaghan (2000).

The development, field-testing, and commercialization of genetically engineered organisms are regulated differently around the world. The present research concerns Bt corn, which was developed, initially field tested, and first commercialized in the United States, but now includes commercial plantings throughout the world. As such, most of the pre-commercialization research into environmental impacts of Bt corn was conducted within the United States under the regulation of U.S. governmental agencies. The regulation and testing of the environmental impacts from GEOs in the United States is the divided responsibility of the Biotechnology, Biologics and Environmental Protection (BBEP) unit in the U.S. Department of Agriculture's (USDA) Animal an Plant Health Inspection Service (APHIS); the Environmental Protection Agency (EPA); and the U.S. Food and Drug Administration (FDA) (Wrubel, Krimsky & Wetzler 1992; Nap et al.

2003). In the case of transgenic Bt crops (where Bt is considered a "plant pesticide" or PIP) the EPA and USDA have joint regulatory responsibility for the *environmental safety* of Bt crops, while the FDA is responsible for determining the *human and animal feed safety* of the crops.

U.S. industry and regulators have considered GE crops to be "substantially equivalent" to non-GE, traditionally bred crop varieties (Dale, Clarke & Fontes 2002; EPA 2001). According to U.S. regulatory policy, if a GE food crop can be characterized as substantially equivalent to its "natural antecedent," regulators can assume that it poses no new health risks, and it can be commercialized (Millstone, Brunner & Mayer 2000). When a lack of scientific evidence exists to either reasonably assure safety or indicate risk, both the Precautionary Principal and the Doctrine of Substantial Equivalence "rely critically on treating a lack of evidence as evidence, which either justifies or requires a particular course of action" (Apel 2000). In the case of the Precautionary Principal, the required course of action is finding additional evidence before proceeding with commercialization; for the Doctrine of Substantial Equivalence, the justification for proceeding with commercialization is the notion that existing food sources can be reasonably used as an indication of whether the engineered food source presents ecological or human health risks. Therefore, if a GE crop is compositionally similar in chemical makeup, further biological, toxicological and immunological testing is not required (Millstone, Brunner & Mayer 2000). In the case of transgenic Bt crops, a consequence of the Substantial Equivalence Doctrine was that much of the pre-commercialization ecological risk research conducted was more-or-less voluntary and relied heavily on ecological studies of microbial Bt insecticides (EPA 2001; Obrycki et al. 2001) and was not published in peer-reviewed academic journals (Wolfenbarger & Phifer 2000). The industry argues that while Bt products are chemically different because they express the Bt toxin, they are substantially equivalent with respect to compositional variables like carbohydrate and protein content and other nutritional measures. Thus, the limited testing done pre-commercialization focused on determining the relative toxicity of that Bt expression to the application of traditional pesticide applications, with some attention paid to impacts on agriculturally beneficial, non-target species. For a more in-depth critique of this approach, see Hilbeck & Meier (2001).

In any discussion of ecological risks from GE crops, it is important to acknowledge that many of the risks discussed in association with GE crops are also considered risks for non-GE crops, such as invasiveness, weediness, toxicity and even biodiversity (Dale, Clarke & Fontes 2002; Snow et al. 2005). However, there are some characteristics of Bt crops that present new challenges to ecological risk assessment, which are discussed below. As is the case in many risk assessment discussions, the focus here is on potential negative impacts from Bt-crops. However, it should be acknowledged that ecological impacts could potentially also have effects on agro-ecosystems that are positive, at least on the surface (Snow 2003). Many of these proposed ecological benefits are still untested, but include the potential for secondary changes to ecological systems in ways that might, for example, remove a virus vector, increase low-tillage practices or positively impact natural control mechanisms (Dale, Clarke & Fontes 2002). For a succinct comparison of the environmental benefits and risks of some common GE crops see Snow et al. (2005, p. 380).

Insect Resistance

The increased planting of Bt crops has raised concerns about a possible increase in the pace of resistance to Bt endotoxins by target species, such as the European corn borer (Alstad & Andow 1995; Gould 1998; Marvier 2001; Obrycki et al. 2001). If resistance to Bt toxins were to occur amongst target pest species, agriculture stands to lose the use of the transgenic crop, as well as an effective microbial insecticide, Bt (Gould 1998).

Although stacking of two or more toxins and differential expression of toxins have been proposed as possible resistance mitigation strategies (Gould 1998), research into resistance management has been pursued mainly through considerations of high-dosing strategies (high toxin concentrations may make resistance alleles more recessive) in combination with spatial refuges ("buffers"), which simulation research shows could greatly increase toxin susceptibility of the ECB (Alstad & Andow 1995; Gould 1998, 2000; Ives & Andow 2002). Research in this area in the last few years has challenged previous understanding of how refuges work, however, indicating that a combination of differences in fitness, assortative mating and variations in male mating success all play a role in resistance management using this strategy (Gould 2000; Ives & Andow 2002). Gould (1998) also warns that resistance evolution may also be impacted by density-dependant influences of mortality caused by natural enemies. And, in the case of the diamondback moth (*Plutella xylostella*), lab studies have been unsuccessful in predicting field resistance due to differences in field exposure and the impacts of immobility during mating (Glare & O'Callaghan 2000). Although Hyde et al. (2001) have shown that within-field refuges are not cost prohibitive for farmers, a possible barrier to using the high-dose/refuge approach to manage resistance will likely be farmer education and compliance with establishing buffers (Alstad & Andow 1995; Dale, Clarke & Fontes 2002; Gould, 1998).

Integrated pest management (IPM) also shows promise to slow insect resistance, as was demonstrated by the delay in cotton bollworm (*Helicoverpa armigera)* resistance in natural refuges derived from the mixed-planting system of cotton, corn, soybean, and peanut on family-owned farms in China (Wu & Guo 2005). However, a disturbing trend in the use of "prophylactic" Bt corn plantings in areas where European corn borer has not historically been a significant pest problem suggests a shift away from this IPM strategy, at least in the United States (Obrycki et al. 2001).

Many of the Bt products currently commercialized express a toxin throughout many plant tissues, and also express it continuously throughout the plant's life cycle. One suggested way to mediate the evolution of resistance is to engineer the plants for limited expression of the toxin—either in fewer plant parts (e.g., not in the pollen) or for a limited timeframe (e.g., only during plant lifecycle phases that are most susceptible to pests) (Glare & O'Callaghan 2000).

Toxin Residue in Soils and Related Soil Community Impacts

Toxins from transgenic Bt corn can enter the soil in three different ways: 1) through pollen deposited in and around corn fields during anthesis; 2) through root systems; and 3) through plant residues (Saxena et al.1999; Zwahlen et al. 2003). Impacts to non-target Lepidoptera from insecticidal Bt sprays have been documented up to 30 days post treatment in field settings (Obrycki et al. 2001). However, Saxena, Flores & Stotsky (2002) found that one Bt toxin (Cry1Ab) was still present in its insecticidal form in soil after 350 days. Variable temperatures in field settings are likely to impact the rate toxin degradation, however, and Zwahlen et al. (2003) found that field toxin levels were significantly lower than laboratory toxin levels after 200 days.

According to Altieri & Nicholls (2001), the potential for soil biota exposure to Bt-crop endotoxins is high due to this possibility of prolonged exposure, especially in the developing world, where farmers often rely on the decomposition of local crop residues by soil microorganisms to protect soil fertility (which could be negatively impacted by slowed natural rates of decomposition/nutrient release). Results from testing the impacts of Bt-crops on microbial communities are mixed, however, and suggest that there is still a lot of research needed in this area. While Saxena & Stotsky (2000) did find increased toxin exposure from Bt crop sources, they did not find a correspondent decrease in soil organisms, such as nematodes, protozoa, bacteria or fungi. And, Shen, Cai & Gong (2006) found no apparent effects on soil rhizosphere enzymatic activities or functional microbial diversity between Bt and non-Bt cotton fields throughout the plant's life cycle.

However, Mulder et al. (2006) found that microbes in microcosms treated with transgenic Bt corn stalks had higher respiration and catabolic rates for 72 hours than those treated with non-Bt corn, indicating a potential influence on short-term ecosystem functioning from bulk soil bacteria.

The binding of Bt toxins with soil particles and acids accounts for their longevity in field settings, which also raises concerns for organisms that consume soil particles as part of their regular diet, such as earthworms (Dale, Clarke & Fontes 2002). Although no lethal impacts were observed, Zwahlen et al. (2003) found that adult earthworms (*Lumbricus terrestris*) consuming Bt corn litter lost nearly one-fifth of their weight over a 200-day modified laboratory trial, vs. four percent weight gain by earthworms consuming non-Bt corn litter. The authors suggest that increases in the lignin content (which is more difficult for earthworms to digest) during the engineering process may account for the decreased in weight, but further research is necessary.

Creating a Weedy Species

According to Pimentel et al. (1989), in the United States alone 120 species of introduced agricultural crops and ornamental plants have become serious weeds. Ongoing ecological debate exists about whether or not the addition of one gene is likely to make a GE crop become a weed (Fitter 1990). Most agree, however, that crops that already have weedy characteristics or have been engineered to present novel traits that would give them a competitive advantage in natural or agricultural settings deserve special consideration (Dale, Clarke & Fontes 2002; Pilson & Prendeville 2004; Regal 1993). According to Conner, Glare & Nap (2003, p. 23), "Whether a plant species becomes a serious weed in a new environment may relate more to its ability to grow well in the new environment, coupled with the absence of effective enemies such as herbivores and diseases."

The commercialized HT crops to date show little evidence of enhanced invasiveness in natural or agricultural settings in the absence of herbicide applications (Dale, Clarke & Fontes 2002). However, some agricultural weeds, such as horseweed (*Conyza Canadensis),* have already evolved resistance to the toxins in these HT crops (VanGessel 2001). In the case of Bt crops, the absence of closely related relatives in the United States has lead the EPA to consider the risk of creating weedy species minimal in the case of Bt corn and soybean, but a potential risk for Bt cotton, where feral relatives are present in the Caribbean, Florida and Hawaii (EPA 2001). Others have documented crop hybridization with wild relatives within the United States for several other cultivated species, including sunflower, sorghum, squash, canola, rice, sugar beet, poplar, and some turf and forage grasses (Ellstrand 2003; Snow et al. 2003). Ellstrand (2003) documented 16 cases of crop hybridization that resulted in a new taxon or wild populations that were weedier than their parents. For sunflower, Snow et al. (2003) reported increased fecundity (seed production) and decreased herbivory from a crop-developed Bt transgene on backcrossed wild sunflower populations in Midwestern and Western U.S. field sites. Quist & Chapela (2001, 2002) also reported the presence of DNA from both Bt and HT varieties in native Mexican corn landraces, but did not investigate potential ecological consequences of this occurrence. The study was hotly contested within the peer-reviewed journal, *Nature* (see McAfee 2003).

As Marvier (2001) points out, the trouble with determining the potential weediness is the long time lag that exists between the introduction of an exotic species and its detection as a weed (which might take 30 years or more). Besides the work done to describe the characteristics of species that make them likely weeds (e.g., Baker 1974), the finite rate of increase (lambda) seems to be the best ecological modeling tool to signal an early warning for the potential weediness of a crop species. Since agricultural crops can be considered discrete, non-overlapping generations, here lambda is represented by the number of seeds produced at time t +1 divided by the number of seeds produced at time t (i.e., $\lambda = St + 1 / St$). For $\lambda > 1$, crop volunteers will increase and create weedy species; for $\lambda < 1$, the crop species will decline to extinction. Conner, Glare & Nap (2003) and Thompson, Thompson & Burgman (2003) argue that looking at a single demographic process has limitations for measuring the potential for plant invasion, but the use of λ as a measure of potential weediness of a GM crop likely will take into consideration many of the demographic factors that could potentially lead to weediness (and thus, be a heuristic tool for the relative risk of the plant in terms of potential weediness).

While most GE crops currently commercialized show a limited threat for weediness, others proposed for development that will be more tolerant of temperature, water and soil extremes, as well as pathogen resistance present a greater threat for invasiveness (Dale, Clarke & Fontes 2002). Where GE species are engineered to be sterile, the potential invasiveness of a GE crop may be somewhat better controlled. However, gene transfer from hybridization is not the only concern; if a GE crop is broadly cultivated, there is also increased concern of increasing exposure to mechanisms of horizontal (to other species) gene transfer as well (Peterson et al. 2000; Regal 1993).

Gene Flow & Hybridization with Wild Species

Another concern is whether or not the GE crop might be able to outcross in regions where wild relatives are present through hybridization (where the F1 progeny will either be unviable, or viable through introgression or transgene stabilization) or with feral crop plants and weed volunteers. Hybridization of crops species with wild relatives has been widely documented for nearly all of the most prominent crop species, and introgression is suggested as likely in theoretical models (Pilson & Prendeville 2004).

The ecological risk here is that, if the novel trait has a positive fitness effect, the transgene may spread through gene flow in wild populations or feral crop plants, causing competitive exclusion by wild/feral plants with the novel trait (Meade & Mullins 2005; Pilson & Prendeville 2004). If the fitness advantage is significant, this could result in localized extinctions of the less competitive genotypes or of other species. In this case, the concern is that the GE trait, insect resistance, would outcross with wild relatives and release these wild relatives from the control that insect pests have on their population (Pilson & Prendeville 2004; Wrubel, Krimsky & Wetzel 1992). The outcrossing success from crop to wild relative is highly dependant on a variety of factors, as well as by the establishment and propagation of the hybridized plants (Conner, Glare & Nap 2003). The use of new molecular technologies (e.g., genetic markers) allows researchers to determine the introgression of genes from crops to native species at centers of crop origin. Quist & Chapela (2001, 2002), for example, reported finding integrated transgenic DNA from Bt corn varieties in native corn landraces that were sampled from remote regions of Oaxaca, Mexico, the middle-American center for corn origin and diversity. Although the research was contested, the finding has raised concern that particular corn traits in native landraces could be endangered by global agricultural practices, including genetic engineering (McAfee 2003). In the case of Bt introgression in Mexico, ecological impacts could result if the Bt gene increases in frequency amongst land races due to a possible increase in seed production as a result of reduced lepidopteran damage (Pilson & Prendeville 2004).

Increases in transgene frequency can result from swamping from a large migration of the GE crop into a population of wild relatives, or by natural selection. Several methods of reducing the possibility of transgene introgression have been suggested, including placing transgenes on chromosomes that are less likely to introgress; linking transgenes to domesticated traits that are expected to decrease fitness; using GE viability/fertility controls; and restricting GE crops from areas where wild relatives occur (Pilson & Prendeville 2004).

Impacts to Non-Target Species

The non-target impacts of Bt endotoxins have been the subject of considerable scientific scrutiny over the past decade—and more so than ever following the Bt-monarch controversy. During the period of the Bt-monarch case, however, non-target risk assessment research was still mainly focused on lethal impacts to single non-target species, and little if any pre-commercialization research was conducted on ecological interactions. In pre-commercialization phases of ecological research, non-target species are examined only if they are likely to be present in field settings, if they have value to agro-ecosystems, if they are threatened or endangered, or if other closely-related species are known to be impacted (O'Callaghan et al. 2005). Non-target research has become more sophisticated since then, however, with additional focus now being placed on sub-lethal effects and complex trophic interactions. Most of this research, however, is still being done within agro-ecosystems and is still not inclusive of interactions in ecosystems that are located proximate to agricultural applications of GE crops (see Obrycki et al. 2001).

As advocated by Obrycki et al. (2001) and others, research has moved beyond the direct impacts to herbivores in agro-ecosystems to focus on Bt impacts to multiple trophic levels, including early study of how the endotoxins move through the food web in agro-ecosystems (Ervin et al. 2003; Groot & Dicke 2002; Harwood, Wallin & Obrycki 2005; Obrist et al. 2005; Torres, Ruberson & Odang 2006). Additionally, newer research has documented decreases in weed abundance in agro-ecosystems as a result of HT crop systems and the related impacts on herbivore, predator, parasitoid, pollinator and detritivore populations (Hawes et al. 2003). These changes in host plant diversity in HT crop systems may have carryover impacts in Bt corn systems, as HT crops are often alternated with Bt corn plantings (or because HT genes are stacked with Bt genes in commercial varieties).

Because microbial Bt has been known to impact some insect predators and parasitoids (Glare & O'Callaghan 2000), researchers have begun to examine how Bt corn might impact these species and their host/prey populations (Lovei, Andow & Arpaia 2009). Studies by Harwood and colleagues at the University of Kentucky found that generalist predators, like slugs, beetles and spiders, were susceptible to increased exposure to Bt endotoxins (Cry1Ab) in field and modified-field studies with genetically engineered Bt corn (Harwood, Wallin & Obrycki 2005; Harwood, Sampson & Obycki 2006; Harwood & Obrycki 2006). As Zwahlen et al. (2003) demonstrated, exposure to these endotoxins over an extended period of time can result in decreases in fitness and weight loss in some species. The finding that spiders may experience prolonged exposure to Bt endotoxins is particularly worthy of further study, as spiders are a natural predator of several agricultural pests and play an important role in integrated pest management (Harwood, Wallin & Obrycki 2005). Ludy & Lang (2006) found that juvenile garden spiders, *Araneus diadematus*, showed no impacts to weight increase, survival, molt frequency, reaction time, and various web variables from Bt corn (Cry1Ab) in a laboratory bioassay.

In addition, research also suggests that the lacewing, *Chrysoperla carnia*, an important predatory insect in corn systems, may have experienced increased larval mortality when feeding on transgenic pollen, and adult mortality from feeding on low-quality prey species in Bt corn fields (Dutton et al. 2002; Hilbeck et al. 1998; Obrycki et al. 2001). Other research has shown Cry1Ab toxins in the herbivorous thrip, *Frankliniella tenuicornis*, had negligible impacts on that non-target species and its common predator (*C. carnia*) (Obrist et al. 2005). However, endotoxins present in spider mites after pollen shed were comparably higher, and transferred to predator species in the *Orius*, *Chrysoperla* and *Stethorus* genera (Obrist et al. 2006). In Bt cotton systems, where the Cry1Ac toxin is expressed at lower, but continuous, levels in cotton plants, Torres, Ruberson & Adang (2006) found that detectable levels of the toxin in some predators (green lacewings, *Chrysoperla rufilabris*, and stink bugs, *Podisus maculiventris*) during periods of high lepidopteran prey abundance. Earlier research also found that one variety of Bt caused increased mortality in domesticated bees, *Apis mellifera* (Vandenberg 1990); however, subsequent research efforts on a variety of Cry toxins have shown no significant impacts from transgenic Bt on mortality, larval survival, pupal dry weight, lifespan or flight activity (Groot & Dicke 2002). Prutz & Dettner (2004) observed that decreased relative feeding rates in one stem borer (*Chilo partellus)* resulted in decreases in emergence success of wasp parasitoids (*Cotesia flavipes)*. The recent research seems to indicate that multi-trophic interactions in each field situation are unique and affected by many factors, including the specific type of Bt protein used and how it is expressed, the community type, soil factors, and even rainfall (Torres, Ruberson & Adang 2006).

As research matures on these non-target food webs, concern has also arisen over how Bt-crop-related decreases in insect prey abundance (including the Bt-target pest, *O. nubilalis*) might also impact bats, birds, rodents, fish and amphibians, as well as parasitoids (Obrycki et al. 2001; Watkinson et al. 2000). Although research appears to be less developed on non-target impacts to vertebrates from transgenic Bt crops, environmental impacts from microbial Bt insecticidal sprays have been documented (Joung & Cote 2000). One area of particular interest in this regard is insectivorous birds. Holmes and others, for example, found relatively little risk to songbirds from microbial Bt treatments compared with other traditional insecticides; however, some "subtle" impacts on warblers, such as a decrease in second clutch attempts/bird/year, fewer caterpillars in diets and changes in foraging patterns were observed (Holmes 1998). Where beta-exotoxins are excluded from the microbial Bt insecticide, research to date suggests minimal impact to fish, amphibians and small mammals (e.g., mice, shrews, voles and chipmunks) (Joung & Cote 2000).

Unintended Consequences & Concern for Overall Sustainability

Current methods for genetic engineering do not insert genes into pre-determined places within the host species genome, and therefore sometimes have unintended consequences on other parts of the genome that are poorly understood and not always immediately evident (McAfee 2003; Regal 1994). For example, pleiotropic effects occur when genetic manipulation results in unintended expression of traits or behaviors, such as greater fragility of plant tissues and increased vulnerability to disease (McAfee 2003).

For example, in their study of Bt impacts on aphids (*Rhopalosiphum Padi*), Lumbieres, Albajes & Pons (2004) postulate that pleiotropic effects on host attraction or plant structure (greener foliage for longer timeframes or olfactory cues) in Bt corn may account for different survival rates between adults and offspring. Saxena & Stotsky (2001) also found that Bt corn had unintentionally higher lignin content than non-Bt corn, which may in some way account for the increased attractiveness of Bt plants. While most ecologists agree that pleiotropic effects that increase ecological competitiveness will be rare, unexpected findings like those above indicate much broader complexity in terms of ecological risk assessment than originally imagined (Regal 1994). Unfortunately, the current U.S. field testing protocols for GE crops are also very limited in their ability to discover such unexpected impacts, usually being carried out in small, isolated conditions for short durations (Altieri 2000; Regal 1994).

Both the general discussion and the in-depth scientific debate over whether or not GE crops are inherently more ecologically dangerous than traditional crop species seems to have pitted the "bad" (GE) against the "good" (traditionally bred crops). In such a light, it is easy to lose sight of the fact that traditionally bred crops have negative ecological impacts, and what has become a "traditional" agricultural practice of creating monocultures controlled by aggressive broad spectrum herbicides is also not sustainable practice in the long term. Attention has been diverted from the fact that mass monoculture agriculture, by whatever means—genetically altered or not—is not a sustainable practice, or a necessarily promising one for alleviating world hunger and starvation (Altieri 2000; Peterson et al. 2000). In terms of the conservation of biodiversity, mass agriculture will still result in the net loss of native species, the removal of vast tracts of native habitat, and the expansion of agriculture into previously unsuitable environments.

Going Forward

As stated earlier, the risks of Bt and other GE crops also come with some potential benefits. Sustainable or not, if we assume that the human species will continue on its current trajectory toward increasingly larger scales of monotypic agricultural (likely a reasonable assumption), it will be important to begin identifying ways in which GE can be used to the benefit of biodiversity conservation. In terms of Bt crops, for example, one obvious opportunity that GE presents over traditional breeding techniques is the ability to target gene expression to only those plant tissues that are susceptible to damage by agricultural pests. In the case of the ECB impacts on corn, expression of the toxins for corn borer need only occur in the above-ground portions of the plant, and the discovery and application of gene promoters that would leave the toxin unexpressed in pollen and roots could decrease some of the ecological risk associated with Bt crops (Dale, Clarke & Fontes 2002). In this sense, Bt crops might actually have less impact on natural systems than the “organic” microbial Bt pesticide. Hilder & Boulter (1999) review several alternative plant-incorporated protectants (non-Bt forms) that may provide alternative strategies for pest management using genetic engineering (little attention is given to their potential ecological risks, however).

As ecologists and conservation biologists grapple with the ecological risks from GE crops, they also stand to gain greater understanding of ecological risks from traditionally bred agricultural products as well, because what they are learning about invasiveness, weediness, toxicity, and ecological complexity will apply in other contexts as well. In was in this spirit that the Ecological Society of America made a number of recommendations for future applications of GE in the environment, including: earlier involvement from ecologists in the planning and development of GE crops; increased attention to earlier and more ecologically comprehensive risk assessment and management research; establishment of a consistent, although adaptive, risk assessment framework for all GEOs that would identify high-risk products early in the development chain; and more multidisciplinary training and collaboration between ecologists, agricultural researchers and molecular biologists (Snow et al. 2005). Ervin et al. (2003) also advocate that future ecological research include expanded ecosystem monitoring and research that "captures the interconnectedness of ecological systems, the essential roles of ecosystem services, nonlinear and threshold responses to accumulating stresses, and the global expansion of the technology" (p. 1).

Focus on Non-Targets: The Monarch Butterfly Case Study

Biology and Conservation of Monarch Butterflies

Species Characteristics and Life History

The monarch butterfly (*Danaus plexippus*) is one of 170,000 species of moths, butterflies, and skippers belonging to the Order Lepidoptera that is susceptible to many of the toxin strains of *Bacillus thuringiensis* (Bt). The monarch butterfly is one of about 5,000 members of the Nymphalidae family (butterflies and moths that are characterized by their undeveloped front legs), and one of eleven species of butterflies in the genus, *Danaus*, known as the milkweed butterflies (Smith, Lushai & Allen 2005).

Perhaps the best known of all butterfly species, the adult monarch is recognized by the distinguishable black, orange and white pattern on its wings, which span 9-11 centimeters. The adult monarch is sexually dimorphic, with the male of the species being distinguishable from the female by its slightly larger size, sometimes-brighter orange coloration, and small circles of black scales (pheromone pouches) on the hind wings (CEC 2008). The monarch butterfly progresses from egg to adult butterfly in about one month during normal summer temperatures (the early spring generations can take up to 60 days), depending on weather conditions, which influence all stages of monarch development (Prysby & Oberhauser 2004; Zalucki & Rochester 2004).

Female monarchs lay an average of 500-700 eggs during their lifetime, placing a single, 0.460 mg (average) cream-colored egg on the leaf of a milkweed plant (Asclepiadaceae family) to start the life cycle (Altizer, Oberhauser & Geurts 2004; Oberhauser 2004b). Eggs hatch in about 3-5 days (Oberhauser 2004a), and the emergent, first-instar caterpillar is usually less than one-half centimeter in length. Monarch larvae (caterpillars) have characteristic black, white and yellow bands. Larvae develop through five instar stages in 9-13 days, growing up to 2.5-4.5 centimeters by feeding only on milkweed plants, which contain cardiac glycocides that monarch larvae are not susceptible to, but carry in their bodies throughout their life cycle (CEC 2008, Monarch Watch). These "cardenolides" are distasteful to bird predators, usually causing vomiting if ingested, and thus discouraging vertebrate predators from consuming the brightly patterned larvae and adult butterflies (Pyle 1999; CEC 2008).

Following the fifth instar, when the caterpillar has completed most of its life cycle growth, the caterpillar pupates. The chrysalis is jade colored with metallic-golden markings and becomes transparent toward the end of metamorphosis, which occurs in 9-15 days under normal conditions (CEC 2008). Adult monarch butterflies live 2-5 weeks in the wild (CEC 2008), and North America usually produces three or four overlapping generations per year (CEC 2008; Prysby & Oberhauser 2004). In the Eastern North American population, the last monarch generation goes into reproductive diapause and migrates to Mexico for overwintering, suspending reproduction until the following spring, when it migrates back north into its breeding range. Calvert (1999) found some females lay eggs in West Texas in late-August/early-September prior to completing their migratory journey to Mexico. The migrating generation can live 7-9 months (CEC 2008).

In the Americas, recent genetic analysis recognizes two distinct monarch subspecies, *Danaus plexippus plexippus*, the dominant migratory sub-species, and *Danaus plexippus megalippe*, the non-migratory sub-species from parts of Mexico (rarely) and South America (Smith, Lushai & Allen 2005). In North America, the core of *Danaus p. plexippus'* spring and summer range extends throughout northern Mexico, the United States and southern Canada. However, the sub-species is also found in the Canary Islands, Madeira, Azores, Bermuda, many Pacific islands, Galapagos Islands, Hawaii, New Zealand, Australia, Moluccas, Philippines, and Taiwan, likely the result of introductions in the 19th Century (CEC 2008; Smith, Lushai & Allen 2005).

Population Biology

Population Description. In North America, monarchs are described as part of three nearly distinct populations: the non-migratory Mexican population, and two U.S. populations—Western and Eastern—divided by an "indistinct line" on the Eastern side of the Rocky Mountains (Dingle et al. 2005). While a small subset of the Eastern population breeds in southern Florida throughout the year (Malcolm & Brower 1986), the rest of that population overwinters in Mexican cloud forests, after overlapping spring and summer generations breed throughout the Eastern two-thirds of the United States and into southern Canada to the northernmost reaches of milkweed distribution, whose 115 North

American species are monarch larvae's host plant (CEC 2008; Dingle 2005; Oberhauser 2004). Although population genetics research is somewhat limited, current species distribution research suggests some genetic interchange between the Western and Eastern populations may be occurring from population mixing in Mexican overwintering sites and seasonal replenishment of the Western population from the returning Mexican overwintering population (Brower & Pyle 2004; Dingle 2005).

Eastern Population Status. The discussion of non-target risk assessment for Bt-corn that follows is focused on the Eastern, migrating population of monarchs, *Danaus p. plexippus,* as it was the most impacted population in the Bt-monarch case. The Western U.S. population was likely less impacted by transgenic Bt-corn, which is planted at a higher rate in the Midwestern Corn Belt. The U.S. Cotton Belt does extend, however, into Texas, New Mexico, Arizona and southern California, where monarchs are present at sometimes-high abundance during the spring and fall migrations, and Bt cotton is becoming more common. The present risk research addresses only potential Bt corn risks, and not Bt cotton risks.

The combination of wintering and breeding population monitoring efforts shows relatively large year-over-year variation in the Eastern monarch population, making long-term trend data difficult to evaluate. However, monarch breeding populations have shown a high degree of spatial synchrony over considerable distances, and most monitoring programs reported lower-than-average abundance from 2002 through 2006, with apparently rebounding populations in 2005 and 2006 (CEC 2008; Koenig 2006).

Wintering population peaks were observed in 1990 and 1996; with troughs in 1998 and 2005. The Long Point National Wildlife Area monitoring site reported a statistically insignificant three percent decline over 11 years, but concluded that more data are needed to confirm the trend (CEC 2008).

Mortality. Sources of mortality in monarchs include factors both abiotic (pesticides, breeding range weather and stochastic overwintering events) and biotic (natural predators and host species interactions). Current research commonly cites mortality rates of 90-95 percent in the pre-adult stages of the life cycle (e.g., Altizer, Oberhauser & Geurts 2004; Calvert 2004; CEC 2008; Prysby 2004; Rayor 2004).

Zalucki et al. (2001) found that host-plant characteristics, particularly the concentration of cardenolides, impacted first-instar survival, which is 3-40 percent in field conditions. Zalucki & Rochester (2004) also report that milkweed patch size impacts immature larvae survival rates—with higher survival associated with single plants or small patch sizes, and higher mortality associated with large patch sizes—likely due to the abundance of local predators.

Climatic factors, as discussed above, impact all of the monarch's life stages, and can have a substantial impact on mortality as well. Brower et al. (2004), for example, estimate that one storm event at overwintering colonies in 2002 likely killed about 75 percent of overwintering monarchs—some 500 million total—when temperatures in the oyamel forest dropped to between –4 and –5 degrees Celsius during a January storm in the region. Weather events can also impact monarchs during their breeding season, where cool weather can reduce egg laying and survival of immatures, as well as impact distribution and abundance of host plants and predators (Zalucki & Rochester 2004).

Parasitoids, including flies, wasps, and protozoa have been found to impact monarch survival (CEC 2008; Altizer & Oberhauser 1999; Prysby 2004). While mortality estimates from tachinid fly parasitism vary widely depending on location (between 1 and 43 percent in the North American populations), one recent study estimated that tachinid fly parasitoids could kill an estimated 13 percent of monarchs (and up to 90 percent in some localized populations) (Oberhauser et al. 2007). Braconid wasp parasitism is considered less common; however, as many as 32 adult wasps have been observed emerging from a single larval host, warranting further study of this parasite's impact on monarch mortality (CEC 2008; Monarch Lab 2008). Bradley and Altizer (2005) found that migratory-generation monarchs infected with the protozoan, *Ophryocystis elektroscirrha*, lost proportionately more body mass per kilometer flown and flew shorter distances and at a slower rate than uninfested monarchs. The finding suggests that the migratory phenomenon may play an important role in reducing this parasite's prevalence in the Eastern monarch population, where generally less than 30 percent of the population is infected, compared to 70 percent or more in non-migrating Florida and Hawaiian populations (Altizer, Oberhauser & Geurts 2004; CEC 2008).

In one field experiment, Prysby (2004) found that Midwestern monarchs are likely susceptible to terrestrial and aerial predators in early life stages as well, in particular from ants (*Formica montana*). Calvert (1999) also speculated that spatial differences in fall migratory egg laying in Texas may be a result of fire ant (*Solenopsis invicta*) predation on eggs and larvae. Adult monarchs are also susceptible to vertebrate predation at their overwintering sites in Mexico, where some researchers have estimated nine percent mortality rates from avian predators and five percent mortality from mice (as cited in Prysby 2004). Observations have also been made of spiders, mantids and dragonfly predation on various life stages; however, experimental data are currently unavailable to estimate their impact on survivorship (Prysby 2004).

Migration of North American monarchs. Discovery of overwintering sites in central Mexico is a relatively recent discovery for North American researchers (Urquhart 1976); of course, local farmers in central Mexico have known the sites on a culturally significant timescale—long enough to incorporate the arrival of the fall butterflies into local culture, calling their arrival during harvest the "day of the dead," and naming the butterflies "doves" and "harvesters" (CEC 2008).

Estimates of the actual size of the North American monarch migration still vary considerably, and are an area of ongoing research and modeling. For example, Brower et al. (2002) estimated that between 100- and 500-million Eastern North American butterflies migrate to one of about 30 overwintering colonies on 12 mountain massifs in central Mexico each fall. (Note that recent research by Dingle et al. 2005 indicates that part of the Western North American population likely travels to Mexico to overwinter as well.) However, Brower et al. (2004) began to second-guess that number as a result of population estimates that could be made as a result of the 2002 storm event, where researchers estimated monarch populations reached more than 65 million monarchs/hectare in some colonies. In normal conditions, the cloud forest environment provides monarchs with adequate moisture, a stable microclimate that doesn't freeze over night, and protection from severe weather events associated with cold fronts (CEC 2008). Within the 10,000 square kilometers that these conditions *might* exist, research suggests that appropriate conditions may only *actually* occur in less than 600 km^2, and access to drinking water may further limit selection of appropriate overwintering habitat in Mexico's dry season (CEC 2008). This concentration of the butterflies into such a small area likely results in estimated monarch densities of 7-60 million monarchs per hectare, depending on the year and location (CEC 2008).

While researchers are still trying to better understand the mechanisms of monarch migration, recent research by Zhu et al. (2008) found that a novel circadian clock likely serves the time function of the monarch's "sun compass" migratory navigation, potentially shedding new light on this unique phenomenon. Others have previously suggested other guiding mechanisms for the monarchs, including the prevalence of critical fall feeding habitat along riverine systems (CEC 2008; Dingle et al. 2005). Substantial North American monitoring efforts are helping to establish stronger breeding range population data, as well as migratory patterns and habitat. These efforts include the Monarch Larva Monitoring Project (MLMP); the North American Butterfly Association (NABA) Fourth of July Butterfly Count; and the Cape May (NJ), Assateague Island

(VA), Hiawatha National Forest (MI), Long Point National Wildlife Area and Point Pelee National Park (ON), Journey North/South and Monarch Watch population monitoring and migration monitoring projects (CEC 2008).

Conservation Challenges

The monarch butterfly faces significant anthropocentric conservation challenges, including habitat loss in both its breeding and overwintering range; contemporary farming practices that emphasize heavy inputs from pesticides and insecticides, as well as GEOs; climate change; and reductions in milkweed populations throughout its breeding range. The monarch is not a threatened or endangered species; however, the International Union for the Conservation of Nature and Natural Resources (IUCN) considers the North American migration of monarch butterflies an *endangered phenomenon* (CEC 2008). In an effort to better coordinate conservation efforts and protect habitat for the monarch throughout its winter and summer migratory flyway, the North American Monarch Conservation Plan (NAMCP) was published in June 2008 and articulates the following core objectives for monarch conservation (CEC 2008, p. 6):

1) decrease or eliminate deforestation in the overwintering habitat;
2) address threats of habitat loss and degradation in the flyway;
3) address threats of loss, fragmentation and modification of breeding habitat;
4) develop innovative enabling approaches that promote sustainable livelihoods for the local population; and
5) monitor monarchs throughout the flyway.

The most immediate conservation threat to the migratory phenomenon of North American monarch butterflies is loss of its overwintering habitat, the oyamel fir-pine forest (*Abies religosa*) in the central Mexican cloud forests (Brower et al. 2002), as well as a 12 percent loss of wintering habitats in California (CEC 2008). Over time, the Mexican forests have been destroyed or degraded by logging, charcoal production, agriculture and water diversion; forest fires, invasive species (mistletoe and bark beetles); and impacts from poorly regulated tourism at conservation reserves (CEC 2008). Recent research indicates that the rate of this destruction is increasing, despite Mexico's presidential decrees of 1980 and 1986, which aimed to protect forest reserves for the butterfly's five-month over-wintering period (Brower et al. 2002). A 1997 symposium in Morelia, Michoacán re-affirmed what scholars had been reporting for years: the needs of local peoples—primarily met through logging and forest exploitation—were in "severe conflict" with the overwintering monarchs (Brower et al. 2002; CEC 2008). In 2000, a new presidential decree expanded the Monarch Butterfly Biosphere Reserve area to more than 56,000 acres and created a large trust fund to compensate local forest users for relinquishing their wood rights (Brower et al. 2002; Borjorquez-Tapia et al. 2003). Whether adequate enforcement and incentives exist to fulfill the decree is a matter of continuing debate. To address the threats to overwintering habitat, the 2008 NAMCP prioritizes as "critical" the assessment, surveillance, protection and enforcement of monarch overwintering habitat.

Alterations to the monarch's breeding habitat are also threatening the species' long-distance migration. In particular, there is concern that a decrease in the milkweed host plant may impact long-term survival of the migratory species (CEC 2008). In North America, the most common milkweed host, *Asclepias syriaca*, thrives in disturbed sites, such as farmlands, livestock pastures and along roadsides and ditches (CEC 2008). North American milkweed distribution is currently negatively impacted by agricultural practices that favor within-field herbicide treatments over tillage, damage from ozone and elevated carbon dioxide levels, mowing of roadsides, and treatment as a noxious weed in some parts of the United States and Canada (CEC 2008). Critical conservation actions identified by the NAMCP include identifying where and when milkweed is a limiting resource in the monarch breeding range; assessing how land use changes impact monarchs and milkweed; strengthening monarch habitat protection strategies on public and private lands; and identifying impacts of climate change on monarch butterfly populations and critical habitat.

Non-Target Risk Confronted: Bt Corn Pollen—Monarch Butterfly Larvae

The controversy over the impacts of Bt corn pollen on the monarch butterfly began in May 1999, when a group of Cornell University researchers published a paper in the British journal *Nature* describing laboratory research that demonstrated that Bt corn pollen may be lethal to monarch butterfly larvae (Losey, Rayor & Carter 1999). The study and its potential implications immediately made headlines around the globe and launched an in-depth U.S. inquiry into the matter, including a large empirical study of the risk of Bt pollen to monarch larvae (Sears et al. 2001), a critique of the U.S. regulatory system for transgenic crops, and the questioning of the future role of GEOs in the global commons (see Figure 3.1, p. 91). The case also provided an important opportunity to test the U.S. risk assessment strategy for non-target species over the course of 2.5 years as risk assessors conducted a fast-paced national risk assessment following Losey, Rayor & Carter's (1999) initial notice of concern. What follows is a review of that risk assessment effort.

Scientific Risk Assessment & Unanswered Questions. [2] Two independent studies reported a potential lethal impact from Bt corn pollen to monarch butterfly larvae. Losey, Rayor & Carter (1999) conducted a laboratory experiment that demonstrated decreased survival, leaf consumption, and average weights for monarch larvae feeding on milkweed (*Asclepias curassavica*) dusted with N4640-Bt corn pollen (event Bt 11). While the authors acknowledged the need for further research, the study was immediately criticized (Beringer 1999, Hodgson 1999, Shelton and Roush 1999) for three reasons: 1) it was conducted in a laboratory instead of under field conditions, 2) researchers visually matched corn pollen densities found on *A. syriaca* within corn fields instead of using a more quantitative method of applying transgenic pollen to the experimental leaves, and 3) the larvae were not given a choice between Bt and unaltered pollen. Jesse & Obrycki (2000) subsequently found increased mortality in monarch larvae from field deposition of MAX 454 (Event 176). In a laboratory study in which multiple concentrations of Bt pollen were applied to milkweed leaves, both Event 176 and Event Bt11 caused higher mortality than non-Bt pollen. The study was subsequently criticized for small sample

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[2] This section is reprinted with minor revisions and updates from Oberhauser & Rivers (2003).

sizes (10 to 16 larvae per treatment) and the inclusion of corn anthers with the pollen applications (Hellmich et al. 2001, Shelton and Sears 2001).

In 2000, a North American research initiative was launched to gather data required to conduct a scientifically robust risk assessment of the potential effects of Bt corn pollen on monarch butterfly larvae. This comprehensive risk assessment addressed the following key questions:

1. At what level are the different varieties (events) of Bt corn toxic to monarch larvae?
2. What density of Bt corn pollen naturally occurs on milkweed plants in and around cornfields?
3. Is there significant temporal overlap between monarch larva feeding and Bt corn pollen shed?
4. What proportion of monarchs breed in and around Bt corn fields?

Using the classical scientific definition of risk

$$\text{Risk} = \text{Toxic Effect X Probability of Exposure}$$
$$R = Pt \text{ X } Pe$$

these questions can be broadly broken down into two categories, the first quantifying the seriousness of the risk (toxicity studies) and the last three quantifying the probability of occurrence (exposure studies). The results of research addressing these questions were published in a collection of six papers in the Proceedings of the National Academy of Sciences in October 2001 (see also Wolt et al. 2003).

Toxicity Studies. Researchers have conducted studies examining Bt toxicity on monarch larvae both in the laboratory and in the field. These types of studies can be viewed on a continuum of progressively more realistic experiments to establish toxicity. The laboratory studies were conducted to establish the sub-lethal and lethal effects of different Bt events. Such information was gathered first by feeding various amounts of purified toxins from different Bt events to caterpillars and quantifying growth and death rates at each level. The next generation of research sought to quantify growth and death rates from feeding the caterpillars various amounts of Bt pollen from the different Bt corn Events. This research was conducted either entirely in the laboratory by dusting leaves with different levels of Bt pollen, or in the field. Modified field studies utilized milkweed leaves dusted with the Bt pollen in the field which were then brought into the laboratory; these had the effect of removing natural events that influence quantities of pollen on the milkweed plants, such as predators, wind, and rain. Alternatively, field experiments with caged (controlling for predation on the monarch larvae) or uncaged (allowing predation) milkweed plants provided more resolution on toxicity by allowing natural events to influence the amount of pollen on the milkweed, providing the most realistic quantification of pollen, growth, and death rates.

At what level is Bt corn pollen toxic to monarch butterfly larvae? Hellmich et al. (2001) conducted laboratory studies to determine lethal and sub lethal effects of four Bt toxins: Cry1Ab, Cry1Ac, Cry9C, and Cry1D. They conducted laboratory experiments using purified Bt toxins in bioassays and both purified and contaminated (with anther fragments) pollen collected from the field to establish toxicity. In bioassays of the purified Bt toxins, Hellmich et al. (2001) found that Cry1Ab and Cry1Ac toxins had both sub lethal (growth inhibition) and lethal effects on first instar monarch larvae, while the Cry9C and Cry1D toxins proved relatively nontoxic. Second, third, and fourth instar larvae were 12 to 23 times more tolerant of the toxins than first instars. In tests of purified Bt pollen obtained from field settings, the researchers found no significant differences in larval growth or mortality for two Cry1Ab Events (Bt11 and MON810), Cry1Ac (Event Dbt 418), Cry9C (Event Cbh 351), and Cry1F (Event Tc1507) when compared to control larvae, but found significant growth inhibition from exposure at all levels above 10 grains/cm2 from the Cry1Ab, Event 176 variety. A key finding of Hellmich et al. (2001) was that inclusion of other plant materials with pollen significantly decreased larval survival in the contamination study of Cry9C (event Cbh 351) and Cry1Ab (event Bt11). Excluding the findings from the contamination study on the basis that anthers found on milkweed in the field setting were not fractured, Hellmich et al. (2001) concluded that Cry1Ab (events Bt11 and MON810), Cry1F, and Cry9C should not have lethal effects on monarch larvae in field settings because they either express low levels of the toxin in their pollen or contain less toxic pollen. Subsequent research has also tested the toxicity to monarch larvae of two new Bt Events under development—one hybrid that expresses both Cry1Ab and Cry2Ab2 proteins (MON 810 x MON 84006; which demonstrated some lethal and sub-lethal impacts in lab bioassays) and another that expresses Cry3Bb1 protein (MON 863, which did not demonstrate lethal or sub-lethal impacts) (Dively et al. 2004; Mattila, Sears & Duan 2005).

Is the amount of pollen found on milkweed in a field setting toxic to non-target larvae? Stanley-Horn et al. (2001) studied the impacts of Event 176, Bt11, and MON810 in the field. They found no differences in survivorship or growth between larvae feeding for 14 to 22 days on milkweed dusted with Bt11 or Mon810 pollen and control larvae, although there was a trend ($p = 0.07$) for lower adult emergence when larvae were exposed to Bt11 pollen from Ontario fields. Even low doses (~22 pollen grains per cm^2) of Event 176 resulted in decreased growth rates, and moderate doses (~67 pollen grains per cm^2) resulted in increased mortality. Jesse & Obrycki (2000) also found increased mortality when larvae were exposed to Event 176 pollen on milkweed leaves collected within a cornfield. Zangerl et al. (2001) compared mortality in monarchs growing near fields in which Event 176 was growing to those growing near non-Bt fields, and found no differences. However, they concluded that rainfall and very high mortality during the study may have been responsible for this lack of effect.

Other Lepidoptera have been the subjects of similar studies. Wraight et al. (2000) and Zangerl et al. (2001) studied the potential impact of Bt corn pollen on black swallowtail larvae, *Papilio polyxenes*, using a combination of field and laboratory studies. This species displayed reduced growth rates and higher mortality in the laboratory when exposed to Event 176 Bt corn pollen at levels observed in the field (Zangerl et al. 2001), but not to MON810 (Wraight et al. 2000). Felke, Lorenz &

Langenbruch (2002) identified lethal doses and also found that small and large white butterfly larvae (*Pieris brassicae* and *Pieris rapae*, respectively) and larvae of the diamondback moth (*Plutella xylostella*) fed less and displayed decreased growth rates and higher mortality when feeding on Event 176 pollen in the laboratory. However, Gathmann et al. (2006) found that the MON810 event had no apparent impact on *P. rapae* and *P. xylostella* when feeding in weed strips along field margins. Jesse & Obrycki (2002) found no effect of either Bt11 or Event 176 on milkweed tiger moth (*Euchatias egle*) larvae.

Exposure Studies. Exposure studies estimate how often a species is in the wrong place at the wrong time. In the case of the monarch butterfly, researchers began to assess exposure rates by determining how much corn pollen typically appeared within Bt corn fields and how far that pollen drifted outside the field. After the amount of pollen present in and around fields was determined, the researchers determined what percentage of the time susceptible monarch larvae were in the field, and how often monarchs actually use milkweed in agricultural settings as a place for egg deposition.

What density of corn pollen naturally occurs on milkweed in and around corn fields? Pleasants et al. (2001) measured naturally occurring pollen densities in and around corn fields in Maryland, Iowa, Ontario and Maryland. Not surprisingly, they found that densities were highest within cornfields and dropped off precipitously within 4-5 meters of the cornfield. Inside the cornfields, 95% of the milkweed samples had fewer than 100 grains per cm^2, with the highest densities of pollen occurring when there was not a rainfall event within the period of anthesis (rainfall events removed anywhere from 54% to 86% of the pollen on the leaves). The authors assessed the effects of several factors on pollen deposition, including leaf characteristics (pollen density is highest along the midrib of the leaf), the position of the leaf on the plant (higher leaves have less pollen than middle leaves), the plant's position in the corn canopy (milkweed within rows had higher pollen density than those between rows), wind direction (milkweed downwind has higher deposition than plants upwind), and rainfall (increased rainfall decreases pollen deposition).

Is there significant temporal overlap between monarch larvae feeding and Bt corn pollen shed? In a multi-state (Minnesota, Wisconsin, Iowa, Maryland and Ontario) survey of co-occurrence of Bt corn and monarch larvae, Oberhauser et al. (2001) found that the temporal overlap between susceptible monarch larvae and corn anthesis was greatest in the northern part of the breeding range. In Minnesota and Ontario, 40% and 62%, respectively, of monarchs produced during the summer were predicted to be larvae during anthesis, whereas these proportions were only 15% and 20% in Iowa and Maryland, respectively.

What proportion of monarchs breed in and around Bt corn fields? Oberhauser et al. (2001) found that female monarch butterflies oviposit on milkweed plants within and around agricultural habitats at rates that are as high as, or higher than, plants in non-agricultural habitats. Even though milkweed density is higher in non-agricultural than agricultural habitat, the large portion of the landscape in agriculture means this habitat produces more monarchs than other habitat types. Oberhauser et al. (2001) estimated that corn-field habitats in Iowa and Minnesota/Wisconsin produce 45 and 73 times more monarchs, respectively, than non-agricultural habitats. Since there is no evidence that monarchs avoid ovipositing in Bt fields, the proportion of monarchs that breed in Bt corn fields will be determined by the proportion of the corn crop that produces the Bt toxin.

Scientific Risk Assessment

Based on evidence in the studies cited above, Sears et al. (2001) concluded that Bt corn pollen from most commercialized varieties did not pose a significant risk to monarch butterfly larvae (except for the Event 176 variety, which industry planned to phase out of commercial use by year-end 2003). To illustrate this, they summarized data from the Iowa field tests, separating their analysis for Event 176 from other events.

Using the risk equation, R = Pt X Pe, risk from Event 176 was estimated at 0.4%. Sears et al. (2001) estimated that the probability of a toxic effect (Pt) on a monarch in a cornfield in which Event 176 was planted was 0.9; 90% of larvae would encounter toxic levels of pollen in a field situation during anthesis. This estimate was based on a lowest observable effect concentration (LOEC) of 10 grains/cm^2 (Hellmich et al. 2001). Sears et al. (2001) estimated that the probability of exposure (Pe) to Event 176 was 0.0042, assuming a 5% adoption rate of this variety, that 56% of monarchs in Iowa were from cornfields (Oberhauser et al. 2001), and that there was 15% overlap between anthesis and susceptible larvae (Oberhauser et al. 2001). This risk would increase with higher adoption levels of Event 176 and farther north, where the overlap between anthesis and larval presence is greater (Oberhauser et al. 2001, Sears et al. 2001).

Using the risk equation, R = Pt X Pe, risk from Bt11 and MON810 was estimated at 0.01%. Sears et al. (2001) used a LOEC of 1,000 grains/cm^2 for Events Bt11 and MON810 (Hellmich et al. 2001). Based on this LOEC, the probability of toxic exposure (Pt) to these Events was conservatively estimated at 0.007. Sears et al. (2001) estimated that the probability of exposure (Pe) to Bt corn pollen by susceptible larvae was 0.168, making the same assumptions as above on the timing and use of cornfields by monarchs, and a 20% adoption rate of these varieties of Bt corn pollen.

Sears et al. estimated "worst-case scenario" risk at 0.047%. This assessment assumed an 80% adoption rate of Bt corn, the maximum allowed by the USDA requirement to establish a 20% refuge of non-Bt corn in all cornfields. It also assumed that Event 176 would be phased out of commercial use and that all future varieties would be equally or less toxic to butterfly larvae than currently used varieties.

Lingering Concerns and Follow-up Research

Sublethal Effects at Various Life Stages. Isolating lethal or sub lethal impacts of Bt pollen on non-target lepidopteran larvae in the field has proven problematic due to high mortality from natural enemies. Mortality rates that are typically between 90% and 97% can mask "add-on" mortality from Bt pollen, even when this add-on mortality may have a significant impact from a population standpoint. In addition, larvae may be exposed to Bt toxins for longer than occurred in most studies, and thus could be more susceptible to sub-lethal impacts (Stanley-Horn et al. 2001). Complicating the analysis of sub lethal impacts is the monarch's complex life cycle, which includes five larval instars, multiple overlapping generations, and a long migration to over-wintering sites in Mexico; any impacts on one stage may affect a subsequent stage. However, published lab studies in which growth rates and sizes of monarchs and black swallowtails fed Bt and non-Bt pollen were compared have shown no sub lethal effects, except in the case of Event 176 (Wraight et al. 2000, Stanley-Horn et al. 2001, Hellmich et al. 2001, Zangerl et al. 2001).

Since the 2000 risk assessment, little additional research has been conducted on sub-lethal effects of Bt corn pollen. One notable exception, however, were a group of five field or modified-laboratory studies that revealed some chronic effects, including findings that 23 percent fewer larvae reached adulthood when they were continuously exposed to Bt pollen (likely creating 0.6 percent additional mortality in the Corn Belt—compared with the PNAS findings) (Dively et al. 2004). The study also found prolonged development time (1.8 days), and decreased pupal and adult weights (5.5 percent). No research to date has addressed concerns about possible effects on adult reproduction or migratory capacities.

Anther Consumption in Field Settings. Anthers from most Bt corn varieties contain a higher concentration of Bt toxin than pollen (Hellmich et al. 2001). Many researchers have argued that inclusion of anther materials skewed the results of Jesse & Obrycki's (2000) toxicity studies. These criticisms suggest that anther presence is an artifact of fracturing anthers in the pollen gathering process, and that monarch caterpillars (especially first instars) wouldn't actually consume anthers in a field setting (e.g., Hellmich et al. 2001). Hence, studies of mortality from milkweed dusted with pollen that included anther parts were excluded from the EPA re-registration process. However, Jesse & Obrycki (2004) demonstrated a consistent trend ($p = 0.1$) of increased mortality when monarch larvae were exposed to MON810 Bt corn pollen and anthers naturally deposited on milkweed plants within a field. They recorded anther densities ranging from 0 to 104 anthers/plant on 86-100% of milkweed plants in transgenic Bt cornfields, and observed monarch larvae feeding on anthers that adhered to milkweed plants with moisture from rain and dew. While this trend does not meet the confidence levels of $p < 0.05$ usually accepted in ecological studies, this study certainly indicates that multiple-year field studies are needed to quantify the potential effects of wide scale planting of Bt corn on monarch larvae, and that it is important to examine within-field mortality resulting from deposition of corn tissues that include pollen and anthers.

Milkweed Presence in Agricultural Fields. While Oberhauser et al. (2001) documented relatively high milkweed density in corn and soybean fields, changing agricultural practices may be affecting the presence of many weeds within crop fields. Researchers from Iowa and Michigan also documented that milkweed made up a higher percentage of total plant coverage on adjacent Conservation Reserve Program (CRP) lands (2%) than within agricultural field and pastureland coverage (0.3%) (Becker 2000). Increased application of broad-spectrum herbicides (e.g., Roundup) due to the widespread adoption of HT soybeans (which typically alternate with corn in common crop rotations), appears to be resulting in lower densities of milkweed in corn fields in the Midwest (Oberhauser, personal communication). This change will reduce the risk of within-field exposure to Bt pollen and plant parts by monarch larvae, but could impact monarch reproductive success by decreasing host plant availability. Likewise, conversion of CRP lands to agricultural use due to the increasing emphasis on corn-based biofuels could exacerbate this host-plant decline. This question about a potential decrease in host plant availability raises two larger questions: 1) what might the long-term impact on monarch butterflies (or other non-targets) be given the current agronomic crop rotation practices utilizing transgenic herbicide tolerant crops in combination with Bt corn?; and 2) how will the current regulatory process effectively evaluate the non-target risks from these practices (or a potential "stacked" transgenic crop that incorporates both Bt and herbicide tolerance—both transgenic traits that have been deemed free of ecological risk independently, but not in combination)?

Antifeedant vs. Toxicity Effects. It is not clear if decreased growth rates in monarchs and black swallowtails fed leaves dusted with Bt pollen (Losey, Rayor & Carter 1999, Zangerl et al. 2001) were due to Bt pollen avoidance, and thus decreased feeding for larvae not given a choice between Bt pollen-dusted leaves and other food, or decreased digestive capacity due to exposure (toxicity). Research has shown that female monarchs do not avoid ovipositing on milkweed plants with Bt corn pollen and anthers on them (Jesse & Obrycki 2003). Since first instars rarely move off their original plant (Borkin 1982) antifeedant qualities and toxicity are likely to have the same effect on monarchs laid on milkweed in Bt cornfields.

Multi-Trophic Effects. Dively & Rose (2002) compared the impacts to within-field invertebrate communities from Bt sweet corn versus the use of multiple insecticide applications to traditional sweet corn crops. They found that the negative impact to invertebrate communities from insecticide applications (five treatments of λ-cyhalothrin) was significantly greater than plantings with untreated Bt corn or Bt corn with one insecticide application. This study, however, looked at invertebrates living on or around the corn plants and did not attempt to quantify the impacts to non-targets feeding on the other plants present in agricultural settings (such as monarch larvae feeding on milkweed). These findings are also limited to the standard agronomic practices of sweet corn agro-ecosystems; standard agronomic practices for field corn usually don't utilize this level of insecticide application. Future research should build on the preliminary examinations of community-level population interactions of species living on non-crop agricultural plants, as well as further explore Bt/non-Bt comparisons in field corn agro-ecosystems and the impacts of GE crops expressing other (non-Bt) insect resistance proteins (O'Callaghan et al. 2005).

Many of the conservation biology-related questions highlighted in Chapter One are not being explored empirically at this time, although some of them were raised in the Biosafety Manual and the Biosafety Protocol (SWGB 1998 and SCBD 2000). Aside from toxicity testing by Mattila, Sears & Huan (2005) little follow-on research has been done to further explore the lingering Bt-monarch questions.

CHAPTER THREE

Newspaper Frame Construction:
Descriptors, Definitions, Images and Sources

Chapter Contents

It is hard to ignore the ongoing, often emotional, public discussion of the impacts of the products of crop biotechnology. At one extreme of the hype is self-righteous panic, and at the other is smug optimism.

(Ellstrand 2002)

Introduction

This chapter (the first phase of framing research) examines how the newspapers used the conventions of source selection, definition, description, labels, and images to construct the cognitive frames that define the Bt-monarch ecological risk story. The research begins with an overall examination of the story characteristics and where the Bt-monarch case references were made in the study newspapers, the *New York Times* (*NYT*) and *Washington Post* (*WP*). The introductory examination scopes out major news events that captured and held the story on the media and public agendas and reveals some differences in how the two newspapers covered the story.

The second part of this research endeavors to dissect the story (via the media articles that represent it) into its constituent parts—the discursive elements and basic journalistic conventions that construct the story and shape its trajectory through time. This "critical read" of the media record teases out the immediate (cognitive) frames that were called upon to tell the story about the Bt-monarch case of 1999-2001. An analysis of the sources used in these accounts helps discern which stakeholder groups are helping shape (or "sponsor") the frames in media accounts. Ultimately, such deconstruction helps develop the later study of the immediate cognitive and deeper cultural frames that tell the story and focus the broader societal discussion of the ecological risks of agricultural genetic engineering (Chapter Four).

Methods

Document Selection. NVivo 2.0.163 was used to examine and code 42 articles in the *New York Times* (*NYT*, n = 28) and *Washington Post* (*WP*, n = 14) newspapers during the timeframe of the Bt-monarch case (May 1999 through September 2001). The search string used to find the articles in LexisNexis Academic database, which was limited to the *NYT* and *WP* for the years 1998 through 2002, was

[gene!] PRE/3 [alter! OR modif! OR engineer!] AND [monarch]

Administrative Reading. The articles were downloaded from the LexisNexis Academic database and imported into the software for analysis. Each article was assigned a unique document number and file name and analyzed for the following attributes: author; date; publication; newspaper section and page; word count; lead focus; and predominance of the Bt-monarch case in the article. All articles were then divided into thirds and jumps (when the story continued to another page in the newspaper) to help identify predominance of sources and locations of discursive elements; leads were coded into basic categories; and sources (direct and indirect attributions) were marked for easier discernment and coding in subsequent readings. Finally, microfiche photocopies of the articles were pulled and compared with the Lexis-Nexis downloads, and notes about story placement, graphics and images were made into the study documents for inclusion in the coding process. Over the course of these administrative tasks, sources used in the media accounts were coded and broad categories were identified for coding information during subsequent readings.

Microanalysis. Following this basic administrative reading of the articles, research continued with a line-by-line, microanalysis of the document data—a second, critical reading of the articles, coding like ideas and passages into the software "nodes" for further analysis and recording patterns and connections with research memos that included operational, coding and theory notes (as suggested in Altheide 1996 and Strauss & Corbin 1998). Documents were coded in random order to avoid bias in one particular timeframe through an open-coding approach that ultimately resulted in several hundred document nodes (Ryan & Bernard 2000). A node is a meaningful grouping of like information or ideas that emerges through the research process. For example, a node was created for "ecological risks," and words and phrases encountered in the media articles were then coded, or linked, to that node if they dealt with that aspect of the story. Essentially, any phrases or groups of sentences that struck the researcher as significant in some way to advancing the "story" being told by the reporter were captured as nodes. As new nodes were added, the researcher returned to previous documents and searched for occurrences of that node. As the research progressed, new nodes ceased to emerge, suggesting that the variety of ideas presented in the media accounts were sufficiently captured by the identified nodes. All told, 177 initial nodes of information were described (Appendix C). Some of these nodes were then broken into sub-nodes to follow promising research threads or to deepen analysis within a particular node.

Uncovering & Reporting Relationships. To address Reese's (2001) warning to avoid compartmentalizing manifest data and thus failing to "capture the tensions among expressed elements of meaning" (p. 8), the nodes were then grouped into four broad categories to begin grappling with the overall lines of discourse used in the articles: 1) descriptors and labels, 2) problem and solution definitions, 3) biotechnology and Bt definitions, and 4) risk and safety definitions. These groupings were used to better understand how the newspapers were representing the issues through their descriptions and definitions of the controversy itself. The research process also examined the use of images and illustrations in each of the case study newspapers, as well as which kinds of sources and attributions were used for information sources. Using descriptive statistics, the research was able to pick out some of the predominant ways the media defined issues that were much greater in frequency than other, alternative ways to define the story. These larger-magnitude nodes were then examined for their constituent ideas and themes, which are described in the research findings. The interplay of these major nodes with other lesser, but persistent, nodes helped define the cognitive and cultural frames described in greater depth in Chapter Four. The frames reported in Chapter Four were triangulated with a number of supporting triangulation documents (Appendix B). The mix of descriptive statistics and categorical reduction was hence married with qualitative description and research triangulation to mitigate the "danger of oversimplification" (Reese 2001, p. 8).

Findings

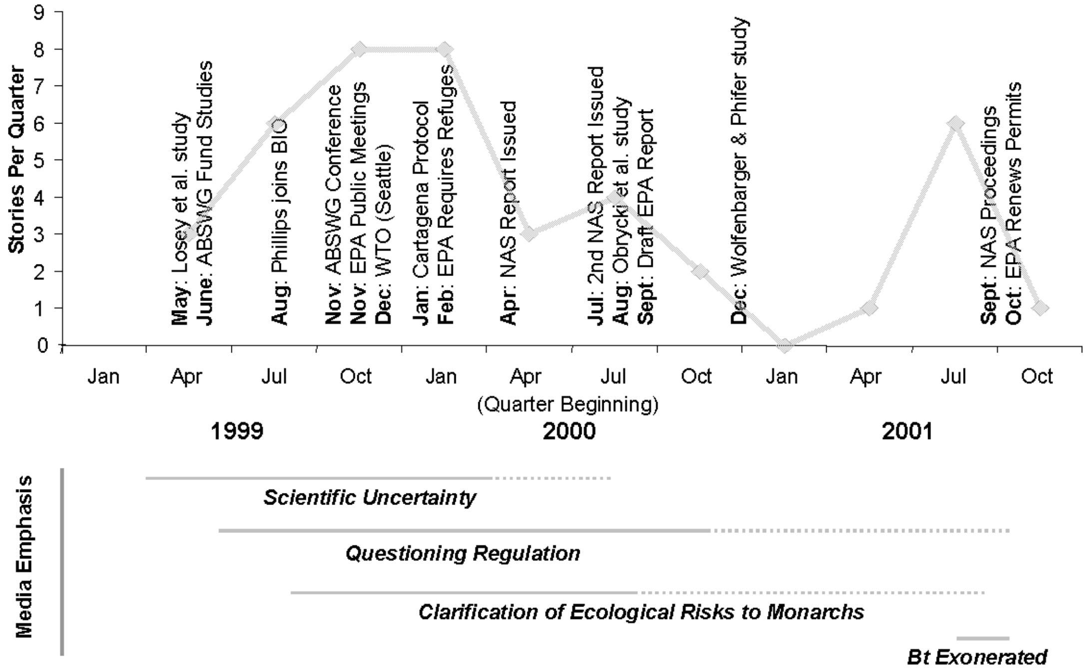
Story Characteristics

Story Development.

Generally, the Bt-monarch case unfolded in four overlapping periods of emphasis in the mass media (Figure 3.1). The emphasis of the story in the early part of the media coverage focused on the scientific uncertainties surrounding ecological risk. The complexity of ecological risk assessments and relative uncertainty of the science at that time were central organizing issues for the story. The second major emphasis in the story was questioning GE crop regulation in the United States. This aspect of the story coverage took on heightened emphasis when Dr. Michael Phillips, director of a National Academy of Science (NAS) panel examining genetically engineered pesticide-producing plants, left the NAS to head up the Biotechnology Industry Organization (BIO).

The third major period of emphasis was an underlying theme throughout most of the 29-month period, the clarification of the ecological risks to the non-target butterfly. As the scientific risk assessment of Bt corn pollen on the monarch larvae progressed, the media reported advancements in understanding and started venturing into reportage of other potential ecological risks from GE crops. Finally, after a virtual hiatus from the story in the early months of 2001, the story re-emerged with an emphasis on exoneration of Bt corn in September and October 2001. At that time, the NAS released a large-scale, multi-authored scientific risk assessment of Bt pollen on monarch larvae, which concluded that the most widely commercialized varieties of Bt corn did not pose a significant risk to monarchs. The EPA subsequently reissued permits to plant Bt corn in the United States in October 2001.

Figure 3.1 Risk Event Timeline Illustrating Overlapping Periods of Emphasis



Notes:

ABSWG: Agricultural Biotechnology Stewardship Working Group
BIO: Biotechnology Industry Organization
EPA: Environmental Protection Agency
WTO: World Trade Organization
NAS: National Academy of Science

Along the way, the story was carried forward by a series of "newsworthy" events that kept the Bt-monarch case on the mass media agenda. Table 3.1 outlines the major events that generated news articles in the study newspapers.

Table 3.1 Summary of Major News Events in the Bt Corn-Monarch Butterfly Case

Timeframe	Event and Description
May 1999	**Losey, Rayor & Carter report preliminary research findings in *Nature*** Covered only in the *NYT* (*WP* doesn't pick up the story until Aug 1999), Cornell researchers publish preliminary laboratory findings that Bt corn pollen might cause increased mortality in monarch butterfly larvae. The researchers conclude the research correspondence article by advocating for further research to confirm the results.
June 1999	**ABSWG funds studies of corn/pollen** The Biotechnology Industry Organization (BIO), in cooperation with other pro-biotechnology organizations, forms a working group to examine the effects of Bt corn pollen on monarch butterfly larvae. The "Agricultural Biotechnology Stewardship Working Group" (ABSWG), with the help of the U.S. Department of Agriculture, creates a grant program for monarch and Bt researchers to study the extent of the problem.
Nov 1999	**ABSWG consortium releases preliminary results** Five months after studies were initiated by the ABSWG, the group holds a conference in Chicago to release "early results," which the umbrella group claims indicate that Bt corn pollen does not harm monarch larvae. At a post-consortium gathering, researchers say the results were far too preliminary to draw any conclusions about the safety of Bt.
Jan 2000	**Cartagena Protocol negotiated** On the heels of a contentious World Trade Organization (WTO) meeting in Seattle, delegates from 140 countries gather in Montreal to negotiate the Cartagena Protocol, an agreement that will govern the international trade of GEOs. At the meeting, the monarch is an oft-cited example of the largely unexplored potential risks to non-target species.
Feb 2000	**EPA requires that refuges be planted to slow Bt resistance** In response to concerns expressed at public meetings in Nov 1999, the EPA requires that spring plantings of Bt corn in the United States have a refuge of 20% non-Bt corn in all fields with Bt corn. The measure isn't put into place to protect monarch butterflies, but rather to slow the inevitable resistance of pest species to the toxin produced by Bt. The EPA recommends (but does not *require*) that refuges be planted downwind from Bt plantings to mitigate risks to monarchs.
Apr 2000	**Preliminary NAS report released, differently treated by *WP* and *NYT*** The National Academy of Science (NAS) releases a long-awaited report on the safety and regulation of genetically engineered, pest-resistant crops (NRC 2000). The panel concludes that GE pest-resistant crops appear to be safe, but need stronger regulation by the EPA, USDA, and FDA. The *WP* story calls the report a "boost to the embattled crop biotechnology industry." The *NYT* lead focuses on engineered crops having "the potential to pose food safety risks and harm the environment" and how the panel has "cautiously endorsed" their safety, while calling for "stronger regulation of the novel plants."
Jul 2000	**NAS issues joint report about the direction of GE crop development** The NAS issues a joint report with the Royal Society of London, the national academies of science of Brazil, China, India, Mexico, and the Third World Academy

of Sciences (NAS 2000). At times critical of the direction of GE crop development, the report generally supports biotechnology and concludes that genetically engineered crops will be needed to feed the growing world population with minimal environmental damage.

Aug 2000	**Jesse & Obrycki study raises concerns** Researchers from the University of Iowa release findings of a modified field study testing the toxicity of Bt corn pollen on monarch butterfly larvae (Jesse & Obrycki 2000). The study shows increased toxicity in the field setting. The study is quickly dismissed because the pollen was not purified and included fragments of corn anthers, which have a higher expression of the Bt toxin than corn pollen.
Sep 2000	**Draft EPA report concludes Bt corn doesn't threaten monarchs** With input from public meetings held in Nov 1999, the EPA concludes in its study of GE pest-resistant crops that the pollen from Bt corn doesn't threaten monarch butterflies (U.S. EPA 2001). The report is widely criticized by environmental groups as being industry biased; industry groups use the report to argue the generic safety of GE crops.
Dec 2000	**Wolfenbarger & Phifer study released** Wolfenbarger & Phifer (2000) release results of a comprehensive literature review of the peer-reviewed risk assessment research that was conducted on GE crops. The results are critical of the industry bias and incomplete ecological risk assessment science conducted before many kinds of GE crops are commercialized.
Sep 2001	**NAS Proceedings released** The NAS publishes a seven-paper special section on the results of a cooperative and nationwide study of the lethal impacts of Bt corn pollen to monarch butterfly larvae. The risk assessment concludes that most varieties of Bt corn pollen are not toxic to monarch butterfly larvae; the one variety (Event 176) that the study finds to be a marginal risk to monarch larvae is in the process of being removed from the market.
Oct 2001	**EPA renews Bt corn permits** Following the release of the NAS risk assessment, the EPA clears Bt corn from having significant ecological risks and renews permits to plant Bt corn throughout the United States for another five years.

Story Depth

The search criteria used in LexisNexis produced varied kinds of articles that referenced the Bt-monarch case. The documents were coded for the amount of information presented about the Bt-monarch case (Table 3.2). Of the 42 articles that referenced the Bt-monarch case, more than half (54%, or 23 articles) only mentioned or referenced the case as part of a story about some other aspect of genetic engineering. About a quarter (24%, or 10 articles) gave the Bt-monarch case a secondary or minor emphasis in the story. Of these articles, the focus was usually either on the regulatory system for genetically engineered organisms or on the controversies created by GEOs. Nine articles, or 21%, were focused mainly on the Bt risks to monarch larvae and other ecological risks from the Bt toxin. All nine of these articles addressed ecological risk assessment for GEOs as the focus of the story.

Table 3.2 Emphasis Placed on Monarch Butterfly in *WP* and *NYT*, 1999-2001

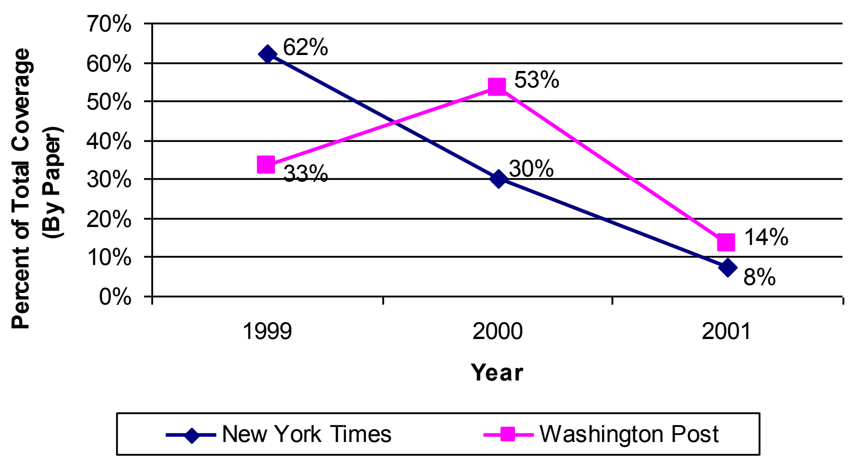
Emphasis on Monarch Larvae	1999	2000	2001	Total
Focus of Story	2	4	3	9
Minor/Secondary Focus of Story	2	4	4	10
Mentioned/Referenced in Story	13	9	1	23
Total	17	17	8	42

Note: In articles where monarch larvae were a minor/secondary focus, the story focused on regulation (5), battle/conflict (3), or ecological risk (2). In articles where monarch larvae were the focus, all of the articles were focused on ecological risk assessment.

While the case received a great deal of coverage in 1999 and 2000 (17 articles each year vs. eight in 2001), there were some differences between the two papers in the level of coverage. The *New York Times* produced twice as *many* articles as the *Washington Post* over the 29-month period, 28 articles vs. 14 articles. At least according to the numbers, the *NYT* also produced *deeper* coverage of the case and related issues than the *WP;* 31,746 words in the *NYT* vs. 11,878 in the *WP*—more than 2.5 times greater coverage. There were also differences in the overall pattern of coverage (Figure 3.2). As a percentage of the total coverage of the subject for its paper, the *New York Times* devoted a majority (62%) of its emphasis on the story in 1999, and gradually covered the story less over time--30% and 8% of total coverage in 2000 and 2001, respectively. The

Washington Post, on the other hand, covered the story more in 2000 (53% of its total coverage) than in the early (1999) and late (2001) periods of the story (33% and 14%, respectively). The temporal distribution of these numbers is significant, because as the controversy developed, different aspects of the story were emphasized. Therefore, the differences in the newspapers' level of coverage suggest a difference in how the papers framed the issues—a point that is further supported when the focus of story leads is analyzed.

Figure 3.2 Percentage of Total Words in Each Paper Devoted to Issues Surrounding the Bt-Monarch Case



Story Focus

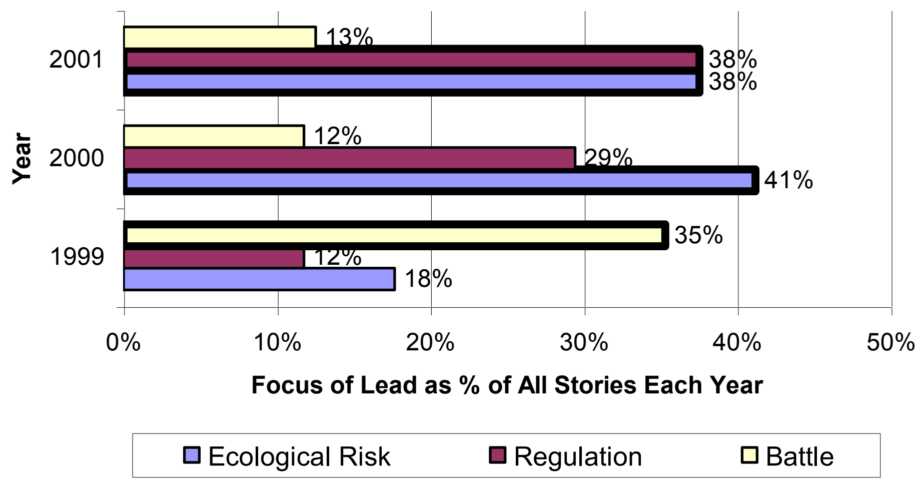
By journalistic convention, the lead paragraph of the story introduces what the journalist deems to be the most newsworthy aspect of the article. Of the 42 articles analyzed, the most frequent leads were those that focused on ecological risks and their assessment (31%), those that dealt in some way with the regulation of GEOs (24%), and those that addressed the issue as a battle between two groups (21%)—those "pro-GEO" and those “anti-GEO.” The other major leads for the articles are presented in Table 3.3. Interestingly, the comparison between the American and European response to GEOs did not appear often in leads (only three of the articles lead with the comparison), even though the comparison is quite persistent throughout the 29-month period.

Table 3.3 Focus of Article Leads Containing References to Monarchs in *WP* and *NYT*, 1999-2001

Lead Focus	1999	2000	2001	Total	% Total
Ecological Risk Assessment	3	**7**	**3**	13	31%
Regulation	2	**5**	**3**	10	24%
Battle/Conflict	**6**	2	1	9	21%
American vs. European Response	**3**			3	7%
Labeling		2		2	5%
Farming	1			1	2%
Economics	1			1	2%
International Trade	1			1	2%
Developing World		1		1	2%
GE Science			1	1	2%
Total	**17**	**17**	**8**	**42**	**100%**

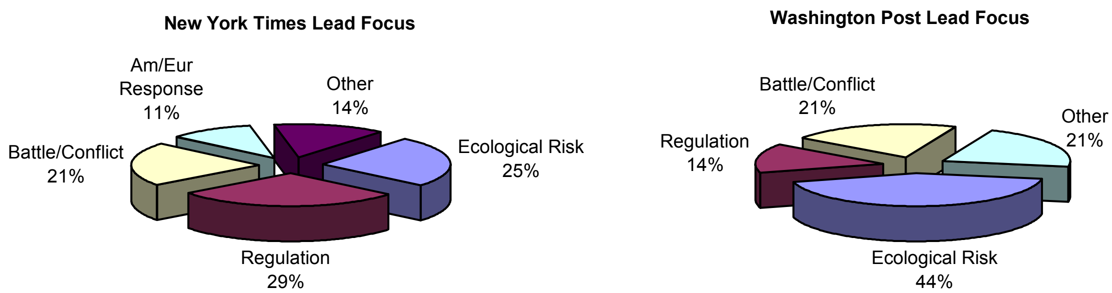
In the three main kinds of article leads (Ecological Risk, Regulation, and Battle/Conflict), some patterns emerge (Figure 3.3). In 1999, almost one-half of the articles begin with either the Battle/Conflict lead or the American vs. European Response lead. In 2000 and 2001, the most prominent leads were focused on Ecological Risk Assessment and Regulation. Thus, while featured as a prominent frame for the story in 1999, the battle lead appears to diminish in prominence over time, and the regulation and ecological risk leads replace it as the story plays itself out. The American-European differences in response to GEOs, while referenced throughout the 29-month timeframe, don’t appear as a focus of any of the story leads after 1999.

Figure 3.3 Focus of Leads as a Percentage of All Leads Each Year



As is evident in Figure 3.4, there are also differences in how the *Washington Post* and the *New York Times* conceptualized the Bt-monarch case. The *New York Times* emphasized the regulatory issues (29%) and ecological risk (25%) most often in its leads, followed by an emphasis on the battles over GEOs (21%). The *Washington Post*, on the other hand, focused its leads more often on the ecological risk (44%) issues, followed by the battle emphasis (21%). The *New York Times* also addressed the differences in the American and European responses to GEOs in three of its story leads; whereas the *Washington Post* didn't give that element of the story any such prominence. In terms of the less-prominent leads used for the story ("other"), the *New York Times* chose to lead some of its articles by focusing on labeling, farming, economics, and international trade issues; the *Washington Post* on labeling, the science of genetic engineering, and issues with developing nations.

Figure 3.4 Percentages of Lead Focus in *NYT* and *WP*



Note: In the *New York Times* (28 articles), "other" leads focused on labeling, farming, economics, and international trade. In the *Washington Post* (14 articles), the "other" leads were labeling, the science of genetic engineering, and issues with developing nations.

Predominant Nodes

Descriptors & Labels

Nodes grouped into this category were the rhetorical conventions, passages or attributed statements that described issues, sentiments, and reactions, as well as how different groups were characterized or labeled in the newspaper articles. Looking at a table of some of the leading descriptors and labels found in this grouping of data, it is easy to visualize the major descriptors and labels used to develop the story frames and progression over time (Table 3.4). It is important to emphasize, however, that the passages coded to each node are not, in themselves, frames; nor are they necessarily *influential* patterns of discourse. *Persistence* of rhetorical conventions and cultural symbols is merely one of the tenets of Reese's (2001) definition of a frame. Calling out the persistent conventions and symbols is, however, a critical first step in explicating how these highly predominant descriptors and labels are brought together and interact with other conventions and symbols to create the cognitive frames that string together the overall “story” of the Bt-monarch case and overall risk assessment for GE crops.

Using descriptive statistics, it is clear that some descriptors and labels are used *much* more often than others. The media describes public sentiment and characterizes research findings far more frequently than other kinds of descriptions and labels (see descriptions of both nodes in Table 3.4). As a percentage of the total number of descriptors and labels coded to this node category, these two nodes are used far more frequently than the next-largest nodes (18% vs. 9% for descriptions of industry actions and emotional Europeans—double in frequency). A third less frequent than the leading descriptors employed by journalists were descriptions of the protests and reactions of environmentalists to the Bt-monarch case (at 6% each), which fell just slightly behind descriptions of farmer sentiments in reportage (7%).

Table 3.4 Top 10 Descriptors and Labels, By Frequency

Node	Description	Example *	#	% Total
Description of Public Sentiment	Journalist characterization of how the public perceives GEOs, an issue, a risk, etc.	… These two events [Cartagena negotiations & Frito Lay not allowing GE corn in Doritos] reflect the unease with which genetically engineered foods have been received. (*NYT* 2/6/00)	67	18%
Characterization of Research Findings	How the journalist characterizes a group/person's reaction to scientific research about monarchs, Bt, or risk assessment.	Just last month, they [critics of biotech] seized on a report suggesting that the monarch butterfly caterpillars and some beneficial insects might be much more vulnerable to a natural pesticide produced by genetically engineered corn than the industry had acknowledged. (*NYT* 6/24/99)	67	18%
Description of Industry Action	Media's descriptions of how the companies react (actual actions) to events and scientific findings.	For the moment, some food and beverage companies like Frito-Lay, Seagram and Gerber are forgoing genetically modified crops so as not to scare off consumers. (*NYT* 2/6/00)	32	9%
Emotional Europeans	Emotive language used to describe Europeans' reactions to or feelings toward GEOs.	In Europe, the debate over genetically modified food is as much about passion as it is about science. (*NYT* 3/14/00)	32	9%
Farmer Sentiments	Describes farmer (both U.S. and European) reactions to GE crops and their plans for planting them during the years of the monarch controversy.	Total American corn and soybean exports slipped briefly, but American farmers are undeterred. Early indications this year from seed companies are that they are not significantly cutting back, because big food processors have agreed to buy modified grains and keep them separate from traditional ones. (*NYT* 3/14/00)	25	7%
Characterization of Protests	How protests are described by the journalist.	Outside, things were livelier. Two protesters dressed as headless chickens strutted. A gorilla wailed over his pox-speckled bananas, and a mutant apple in a radiation suit passed out leaflets. The demonstrators played a tape of bubbling cauldrons and vile belches, and the perfect fillip was the stench that hung in the air -- which was not even their idea, just dumb luck that a sewer crew was working nearby. (*NYT* 3/14/00)	21	6%

Environmental Sentiment	How journalist characterizes the environmental groups' reactions to things--regulations, studies, industry activity, etc.	While scientists and environmentalists largely welcomed the rules, which are to take effect this spring, some criticized the agency for seeking only voluntary protection of the butterflies … Dr. Goldburg expressed concern that biotech companies had been given the responsibility for encouraging farmers to protect monarchs. (*NYT* 1/17/00)	21	6%
Industry Sentiment	How the journalists characterize the industry groups or biotech companies' reactions to protests, research, activities, etc.	For Europeans, "It's not at the level of a rational discussion any more," said Francois Perroud, a spokesman for Nestle … "It's become a battle of doctrines, of religious beliefs, of inanities," Mr. Perroud said. "But unfortunately more and more retailers have jumped on the bandwagon and banished these products from their shelves." (*NYT* 3/14/00)	19	5%
Response to "Anti's"	How the journalist reports the response to protest groups or others who question the regulation and/or use of GEOs.	He [Greenpeace representative] was criticized by an African official of the United Nations Food and Agricultural Organization, who said, "Organic farming is practiced by 800 million poor people in the world because they can't afford pesticides and fertilizers -- and it's not working." (*NYT* 3/14/00)	16	4%
Response to Cornell Study	How stakeholders respond to the Cornell study, and how they characterize the study in the context of the debate.	Seed companies and biotech industry groups have attacked the Cornell study, taking issue with its methods and the conclusion that Bt corn pollen harms monarch butterflies. (*NYT* 1/17/00)	16	4%
Total **			**372**	**85%**

* The examples illustrated here were among the first in the list that appeared in a recall of all text coded to the node described, and are therefore from the earlier articles written on the subject. They are not meant to be representative of all the text coded in a particular node, but to illustrate the kinds of information coded in this group.

** 56 other phrases were coded into this category, but are not described in the above table of the top 10 nodes for this category. Hence, the total here, 372, includes these data outside the top 10 nodes. The last 15% of the data coded, but not described in this table, were coded as Scientist Sentiment (n = 14), Anti-American Sentiment (13), Characterization of Opposition (10), Consumer/Grocer Reaction (7), Government Reaction (6), Developing World Sentiment (5), and Support for Biotechnology (1).

While the level of frequency *by itself* is not a good indicator of frame predominance, it is one of the criteria for Reese's (2001, p. 11-12) definition of a frame: *persistence* (or, routine use and durability over time). The fact that these labels and descriptors are used with such frequency is an indication of their possible significance; however, this should not be overstated. Just because an idea, definition or label appears frequently, does not necessarily mean it resonates deeply with an audience or carries a significant load of meaning or framing power. Focusing only on frequency—as some more quantitative content analysis methodologies tend to do—would miss the other important elements of the Reese (2001) definition of a frame: the capacity for organizing and structuring information, as well as being principle-based, shared, and symbolic. Thus, having met an initial criterion for consideration of a frame, persistence, it is necessary to further scrutinize these leading descriptors and labels for other elements in the definition of a frame. Further analysis of the highest-magnitude nodes is necessary to gain further descriptive detail about their distribution throughout the media coverage. Because two nodes were noticeably more prominent than the others in this category, both descriptions of public sentiment (Table 3.5) and the characterization of research findings (Table 3.6) were parsed for deeper analysis by creating sub-nodes within each of these descriptor/label nodes.

Public Sentiment. A closer look at the frequent descriptions of public sentiments reveals some interesting facets of this node. First, all phrases coded to this node were from articles written between June 1999 and July 2000. The temporal distribution of this node seems to indicate that the public opinion about GEOs, and the Bt-monarch case itself, were worthy of mention by media practitioners in the early stages of the story, but were of less significance later on in the story, when references to public opinion disappeared from media discussion altogether.

Table 3.5 Further Breakdown of Public Sentiment Sub-Node

Public Opinion	# References (% of Total)	Papers	Timeframe
Public as Irrational/Emotive	13 (15%)	*NYT* & *WP*	8/99-3/00
Public Uneasy or Fearful	12 (14%)	*NYT* & *WP*	6/99-4/00
Confidence (or Lack of) in Regulation	10 (11%)	*NYT* & *WP*	6/99-6/00
Public Doesn't Want GEOs	9 (10%)	*NYT* & *WP*	8/99-3/00
American Public Apathetic	8 (9%)	*NYT* & *WP*	6/99-1/00
American-European Comparisons	8 (9%)	*NYT* & *WP*	6/99-12/99
Public Generally Uninformed	7 (8%)	*NYT* & *WP*	8/99-6/00
Public Opinion Important **	7 (8%)	*NYT* & *WP*	6/99-7/00
PR Problem for Industry	5 (6%)	*NYT* & *WP*	11/99-7/00
Public Doesn't See Benefits	3 (3%)	*NYT*	6/99-3/00
Sentiment for Monarchs	2 (2%)	*NYT* & *WP*	11/99-1/00
Public Opinions of Labeling	2 (2%)	*NYT* & *WP*	9/99-11/99
Public Receptive to GE	1 (1%)	*NYT*	3/00
Dislike of Biotech Companies	1 (1%)	*NYT*	8/99
Total	**88 ***		

* Note that this total doesn't match the number of phrases coded to the public opinion node (n = 67). This is because some phrases are coded to multiple sub-nodes. For example, a phrase that is coded as "American-European Comparisons" might also contain sub-node coding for "American Public Apathetic," "Public as Irrational/Emotive," "Public Uneasy for Fearful," "Public Generally Uninformed," and/or "Dislike of Biotech Companies."

** "Public Opinion Important" was the longest-lasting sub-node, covering the entire period of the Public Sentiment node timeframe.

Second, the most prominent of these sub-nodes are descriptions of public opinion that are emotive or sentimental in nature, as opposed to public opinions based on rationality or critical thinking. The top public opinion descriptors were either "Emotive/Irrational" or "Uneasy/Fearful," accounting for nearly 30% of all public opinion attributions. The percentage of sentimental-based descriptions of public opinion is even higher (nearly 40%) if descriptions of the public as apathetic (n = 8) and the sentimental descriptions of monarchs (n = 2) as “popular creatures” (*NYT* 1/17/00) that the public is “fond of” (*WP* 11/3/99) are also included in this category.

A third finding is that the most enduring of these sub-nodes (“Public Opinion Important”) is the notion, or realization, that public opinion about GEOs is extremely important to the long-term development, acceptance and eventual worldwide application of genetically engineered crops (at least as envisioned by the crop biotechnology industry). There are a few interesting facets within the Public-Opinion Important sub-node itself. Consider these three examples:

> (1) This in turn could kick off a string of public reactions leading to drastic regulations that stifle many biotechnology applications. A Presidential candidate who is courting environmentalists could be cast as the leader of the anti-biotech charge (*NYT* 6/24/99).

> (2) At stake in this contest for American public opinion are billions of dollars in investments by the biotechnology industry and American farmers who have rapidly adopted products like corn, potatoes and soybeans that have been engineered to resist pests or produce higher yields (*NYT* 11/12/99).

> (3) "I think the [biotech] companies are ready to share some technologies as long as it doesn't backfire on them commercially," said Alberts [referring to Bruce Alberts, president of the National Academy of Sciences]. "They are suffering from public pressure now and want to do some things that are a public service" (*WP* 7/11/00).

While all three examples indicate the importance of public opinion, the emphasis is slightly different over time. In the first example, the emphasis is on the industry fear that negative public opinion for GEOs might lead to "drastic regulations" on crop biotechnology that could thwart progress. In the second, the emphasis turns to the billions of dollars that could be lost by crop biotechnology companies if public opinion is not accepting of GEOs. In the last, the emphasis is on how the industry might make a "public service" concession in order to influence public opinion favorably toward crop biotechnology. Note what is constant throughout these, and most other references to public opinion importance, is the emphasis on how the public opinion is meaningful due to its relationship to the capital market: if public opinion is negative, it is not significant because it means people don't approve of the technology or are genuinely concerned about human health and environmental risks, but because that opinion could impact the way biotechnology business is done in the United States (in terms of regulation, finance, and the types of products developed).

From a framing perspective, the "importance of public opinion" sub-node may be significant because the nature of its existence has cultural roots in the U.S. notion of democracy and its relationship to a free market economy. Consider the emotive emphasis on descriptions of public opinion in this light. Here the principle actors in American democracy, the people, are *not* portrayed as forming their opinions of Bt corn based on rational thought, but on emotion (and, worse, Europeans are accused of outright *irrationality,* and even *Anti-American* sentiment). As the story of the Bt-monarch case progresses, the assumption of industry seems to be that instead of giving the American public the scientific information that it needs to evaluate the ecological risks from Bt corn, biotech companies may need to make a public service concession to appeal to

America's emotions about the technology. This assumption is also evident in the "PR Problem/Mistake" node, coded 27 times in the Problem or Solution Definition category (see below p. 114). The industry (and sometimes authors of National Academy of Science publications) repeatedly uses newsworthy events and new research findings to insert into the public discourse the notion of generic safety (of the 21 passages coded to the "generic safety" sub-node, half were directly or indirectly attributed to industry sources), coupled with doctrines of technological necessity and humanitarianism (of the 20 passages coded to the "Feed the World" node, again half could be directly or indirectly attributed to industry sources). The journalists covering the story were not quite as cynical about the American public's critical thinking skills, however, and attempted to explain the science behind risk assessment by citing and characterizing research throughout their articles.

Characterization of Research Findings. A closer look at the characterization of research findings sub-node also reveals some trends in the use of scientific research by these two media outlets (Table 3.6). Both newspapers used four primary sources of research information when discussing the Bt-monarch case: Losey, Rayor & Carter (1999), the six papers in the Proceedings of the National Academy of Sciences (2001), Jesse & Obrycki (2000) and the preliminary findings from the Agricultural Biotechnology Stewardship Working Group's (ABSWG) November 1999 research consortium in Chicago (unpublished data). References to these research efforts represented 80% of all references to scientific research reported in the Bt-monarch reportage. While these research studies were certainly not the only, or even primary, sources of information that journalists and editorialists used to write their articles, they are the bodies of scientific research that journalists most cited to the public as evidence for their particular points of view or arguments about the Bt-monarch case. Therefore, how the journalists characterized that research is potentially influential for public understanding of the science behind the controversy and how Americans ultimately construct a shared notion of ecological risk surrounding GEOs.

Table 3.6 Further Breakdown of the Characterization of Research Findings Sub-Node

Characterization of Research Findings	# References (% of Total)	Papers	Timeframe
Losey, Rayor & Carter	20 (27%)	*NYT* & *WP*	6/99-9/01
NAS Proceedings—2001 risk assessment	18 (24%)	*NYT* & *WP*	9/01
Jesse & Obrycki	13 (17%)	*NYT* & *WP*	9/99-9/01
Biotech Consortium	9 (12%)	*NYT* & *WP*	11/99
Pusztai	3 (4%)	*NYT*	8/99
EPA Report	3 (4%)	*NYT*	9/00
NAS 2000 Report	3 (4%)	*WP*	4/00-7/00
Other Studies / Pre-commercial research	3 (4%)	*NYT*	7/99-9/00
Taylor--Brazil nut research	2 (3%)	*WP*	8/99
Wolfenbarger & Phifer	1 (1%)	*NYT*	12/00
Total	**75 ***		

* Note that this total doesn't match the number of phrases coded to the "Characterization of Research Findings" node (n = 67). This is because some phrases are coded to more than one sub-node (e.g., "earlier papers reported that…" would be coded as a reference to the Losey, Rayor & Carter work, as well as the Jesse & Obrycki research.)

One example of how the newspapers characterized research in different ways is how each presented the original research that launched the massive research inquiry into the Bt-monarch case, that of John Losey and his colleagues at Cornell University. The papers reported the research with a slightly different, but telling, use of verbiage. The *NYT* mostly described the findings of the original research as Bt corn pollen "killing" monarch larvae; whereas, the *WP* nearly always used more tempered vocabulary to describe the result of the research—monarch larvae were either "harmed" or "died" as a result of ingesting Bt corn pollen. The *WP* properly called the Losey research "preliminary" and seemingly understood from the start of its coverage that field research would be necessary to confirm the result, correctly cautioning in its first reference to the study that "the laboratory study leaves unresolved whether monarchs are actually being harmed around cornfields" (*WP* 8/15/99). The preliminary nature of the research was clearly established by Losey, Rayor and Carter in the conclusions of the article, as well as in the Cornell University news release that was released at the time of publication (emphasis added):

> Says John E. Losey, Cornell assistant professor of entomology and the primary investigator on the study: "We need to look at the big picture here. Pollen from *Bt*-corn could represent a serious risk to populations of monarchs and other butterflies, but *we can't predict how serious the risk is until we have a lot more data*. And we can't forget that Bt-corn and other transgenic crops have a huge potential for reducing pesticide use and increasing yields. *This study is just the first step*, we need to do more research and then objectively weigh the risks versus the benefits of this new technology." (Cornell University, 1999)

The *NYT* also began to present the Losey, Rayor & Carter research within a broader context early in the fall of 1999, when it reported that Laura Hansen Jesse and John Obrycki, from Iowa State University, were "following up on the experiment in the field," (*NYT* 9/8/99). While both newspapers addressed the Jesse & Obrycki (2000) research in their coverage of the case, only the *NYT* found the anther issue worthy of further discussion and concern. While the *NYT* reported in its coverage of the *NAS Proceedings* that the anther issue, which came to light as a result of the Jesse & Obrycki research, was still unresolved by the research (9/9/01), the *WP* stopped reporting on the anther issue after one of three August 2000 editorials in the newspaper dismissed the research as flawed (Porter, 8/31/00).

One other interesting comparison exists in how the papers differently characterized research findings. The Biotech Industry Organization, through the Agricultural Biotechnology Stewardship Working Group (ABSWG), held a research meeting to discuss *preliminary* research findings of field research that it had co-sponsored with the U.S. Department of Agriculture on the impacts of Bt corn pollen on monarch larvae during the summer of 1999. The day following the meeting, the *WP* produced a long story with several researchers quoted on the consortium under the title, "Gene-altered corn's impact reassessed; Studies funded by Biotech Consortium find little risk to Monarch butterflies," (11/3/99). While the story mentioned once that the findings were "early results," the general tone indicated that the research would ultimately conclude that monarchs were not harmed by Bt corn pollen. Researchers were quoted or paraphrased to bolster this conclusion:

> "I'm assuming the risk of the hazard to monarch larvae is very minimal."
> Mark Sears, University of Guelph
>
> "But in general, he [Pleasants] said, monarchs feeding more than a yard from a corn field are probably '100 percent safe.'"
> John Pleasants, Iowa State University

By contrast, the *NYT* sent a reporter to the meeting, but did not cover the preliminary findings as a stand-alone story. Instead, the paper mentioned the consortium research in a piece it was producing on "Redesigning Nature" more than a week later. The segment in the series addressed the "battle for public opinion" over agricultural biotechnology and described how BIO had tried to "spin" the preliminary results of the consortium researchers by sending out a pre-meeting press release that announced:

> that the meeting was expected to show that genetically engineered corn did not harm monarch butterflies, even though no scientists later polled by a reporter said they could draw such a conclusion and most of them acknowledge that their research was far from complete. (*NYT* 11/12/99)

The *NYT* article focused on how the meeting was spin-doctored by industry public relations practitioners and, in contrast with the *WP* article a week earlier, didn't cite any of the preliminary research findings. The motivation for wanting positive press coverage, according to the *NYT*, was the EPA's desire to have partial data on impacts to monarchs so it could reach a decision about spring 2000 Bt corn plantings (the EPA ultimately called for refuge plantings).

The reporting of the NAS risk assessment research in September 2001 marked the "end" of the Bt-monarch case in the *Washington Post*. A search for "Bt corn" in the LexisNexis Academic Database for the years following the Bt-monarch case revealed only a handful of references to Bt corn. The paper published 300 words on the closing of the subject in its Science Notebook section under the headline, "Biotech corn can pose threat," which succinctly summarized the NAS findings:

> Although one of the five new papers found that the type of modified corn tested at Cornell could harm monarchs inadvertently, the others concluded

> that variety was rarely used and other varieties posed no threat. (*WP* 9/17/01)

The *New York Times*, by contrast, published three stories (two on the NAS findings themselves, and one on the renewal of permits to plant Bt crops by the EPA) and one editorial from Greenpeace on the NAS findings. The two *NYT* articles about the NAS findings were published on September 8 and 9, and emphasized the ongoing themes of industry/government collusion and controversy, as well as the ongoing scientific debate about whether toxins expressed in anther fragments and sub-lethal impacts to butterflies were adequately addressed by the risk assessment. The second of these articles also contained five paragraphs of information describing the risk assessment research findings and four paragraphs describing the lingering purified/unpurified pollen question. The short Greenpeace editorial, published the day of the 9/11 terrorist attacks on the United States, criticized the EPA's regulatory philosophy, concluding that the approach "puts biotechnology industry interests ahead of environmental protection" (*NYT* 9/11/01).

By simply parsing the characterization of research findings and the descriptions of public opinion, some trends emerge in how the Bt-monarch case was being defined by various groups and the media. The crop biotechnology industry and its proponents, for example, appeared to endorse the view that the Bt-monarch case (and GE in general) was a battle for popular opinion, more so than the pursuit of science-based risk assessment:

> Some executives at bio-engineered seed companies say their mistake was to regard the farmer and not the consumer as the customer. With no apparent benefit, it is easy to shun [crops with] even a miniscule risk, just

> to be safe. That puts the industry in a position of having to prove absolute safety, which is impossible. (*NYT* 2/6/00)

And, in an Op-Ed piece written by the University of California—Davis Biotechnology Program Director Martina McGloughlin:

> I agree with the NAS report that more awareness of the regulatory process is needed. Because without any doubt the biggest problem with our robust, logical, science-based regulatory system is that not enough people understand how it works. The real issue is ensuring that individuals have factual, science-based information so that they can make informed decisions. (*WP* 6/14/00)

The result of this industry position was a well-publicized effort to pour millions of dollars into public relations to "get the word out" about the benefits of biotechnology (*NYT* 8/23/99, 11/12/99, and 11/19/99). The industry also made it clear that if further ecological risk assessment was needed, the public should not look to the private sector to foot the bill (attributed to BIO Executive Director Michael Phillips, *NYT* 12/19/00).

There also seem to be differing interpretations of the risk assessment science described in the newspaper coverage. Both newspapers seem a bit unclear about how risk assessment science progresses or how to interpret differences in scientific opinion, and thus display an intriguing tension in defining what the actual ecological issues are with the fast-commercializing technology. Thus, this research progressed from that tension, teasing out how the newspapers defined the issues of concern through the explication of the problems with GE (and their potential solutions).

Brante (1993) has argued that science controversies are characterized in the mass media as one of two principle types: 1) those concerning knowledge claims (in this case study, for example, whether laboratory results are valid measures of risk) or 2) those constructed from ethical or socio-political issues (e.g., whether pre-commercialization ecological risk research is reliably unbiased from market forces). While the press coverage of the Bt-monarch case presents both kinds of scientific controversy, findings here support Miller's (1999) contention that science stories gain lasting media attention—become "newsworthy" enough to stay on the media agenda for a prolonged period—when they are linked to broader social controversy. Only 51 passages across 18 media articles highlight disagreements over knowledge claims—scientific uncertainty (38 passages) or questionable science (13). As became evident during examination of the "Problem or Solution Definitions" category, the *NYT* and *WP* were much more focused on the regulatory issues with agricultural GEOs than the knowledge claims about scientific research.

Problem or Solution Definitions

Nodes within this category describe how journalists define the emerging concerns surrounding GEOs (and the Bt-monarch case in particular), what they articulate about the solutions that have been proposed by various stakeholders (or themselves), or what journalists see as the overall scope of the problems associated with the technology. The category, in essence, includes any of the many issues surrounding genetic engineering that helped define or shape how the GE problems were socially and scientifically constructed. Examples of data coded into this node are presented in Table 3.7.

Regulation as a node in this category clearly stands apart with 207 passages (35% of all passages in this category). This suggests that journalists saw regulation as a major problem with the development of GEOs; the monarch butterfly was an example (or, potential casualty) of a failed regulatory system for this new technology. Of secondary prominence—only half as frequent with 110 passages coded (19% of all coded to the category)—was the definition of the problem as a conflict between two "sides."

Table 3.7 Top 10 Problem or Solution Definitions Identified, By Frequency

Node	Description	Example*	#	% of Total
Regulation	Any discussion of how GEOs are regulated nationally or internationally--including discussion of problems with regulation or of the extent of regulation.	The Environmental Protection Agency has announced new regulations aimed at reducing the risks from corn genetically engineered to produce its own insecticide. (*NYT* 1/17/00)	207	35%
Battle/Conflict Rhetorics	Language evoking the battle metaphor over GEOs. Also, language that perpetuates the "newsworthiness" of the story as one in which conflict exists.	Nearly a decade later, just as mad-cow disease struck, the first American crop with some herbicide-resistant soybeans was on the ocean. Advocates [of more stringent regulation] still talk about the 1996 crop as if it was the Normandy invasion. (*NYT* 3/14/00)	110	19%
Rising Concern	Descriptions of how the issue is becoming more salient--how people are becoming more aware of the potential risks from GEOs and GE technology.	Today's protest, however, may indicate some swelling in the opposition. Last December in Oakland, Calif., only a few hundred people protested ... Today, the crowd nearly filled Boston's Copley Square before the march ... (*NYT* 3/27/00)	37	6%

PR Problem/Mistake	The notion that the real problem isn't really science, but public relations. Also, any discussion of the PR problems or missteps that individuals or groups made along the way.	Some executives at bio-engineered seed companies say their mistake was to regard the farmer and not the consumer as the customer. With no apparent benefit, it is easy to shun even a miniscule risk, just to be safe. That puts the industry in a position of having to prove absolute safety, which is impossible. (*NYT* 2/6/00)	27	5%
Serious Science	Notion that there has been a lot of serious scientific scrutiny of GEOs. Also, notions of safety because of perceived serious scientific scrutiny.	"Dr. Obrycki's research stands in the shadow of more than 20 independent studies by widely recognized scientific experts who have found that Bacillus thuringiensis corn does not post a significant risk to the monarch butterfly" [Giddings] said. (*WP* 8/22/00)	25	4%
Feed the World	Argument that GE is the way the future will feed the world—analogies to the "green revolution."	Creators of the products describe them as crucial to feeding an ever-expanding global population (6 billion and counting). (*WP* 1/24/00)	20	3%
Global Trade Issues	Discussion of the various trade issues related to GE and its non-acceptance abroad.	Part of the reason is agricultural protectionism. Europe resents the fact that many of the patents on genetically modified crops with bred-in high yields and resistance to parasites are held by American companies like Monsanto, DuPont and Dow. (*NYT* 6/27/99)	19	3%
Manipulation by Industry	Notion that industry is manipulating policies or research findings to protect itself or the biotech industry. Also notions of conflict of interest.	Even though the panel called for stronger regulation, some groups criticized the report, saying that it had been tainted by the industry ties of 6 of the 12 members on the panel that wrote it. (*NYT* 4/6/00)	16	3%
Substantial Equivalence	Notion that GEOs are virtually the same as traditionally bred counterparts.	Supporters say that the process is not substantially different from cross breeding a tangerine and a grapefruit to produce a tangelo, and that it offers enormous potential benefits like higher nutrient value and less dependence on pesticides. (*NYT* 2/9/00)	13	2%
Cost- or Risk-Benefit Analysis	Any discussion of cost- (risk-) benefit analysis, or how society should weigh the potential benefits against costs.	The companies still believe in the promise of the technology but now wonder whether they will be able to convince regulators and the public that the benefits outweigh the risks. (*NYT* 6/24/99)	12	2%

Conflict of Interest	Any description of the conflicts of interest that exist in regulatory agencies or by scientists that are being funded by industry or the government to do research.	"Regretfully, I would have to say this report is tainted by the conflicts of interest of members," said Rep. Dennis J. Kucinich (D-Ohio, who has introduced legislation that would require labeling of products whose ingredients include genetically engineered crops). (*WP* 4/6/00)	12	2%
Total**			**498**	**85%**

* The examples illustrated here were among the first in the list that appeared in a recall of all text coded to the node described, and are therefore from the earlier articles written on the subject. They are not meant to be representative of all the text coded in a particular node, but to illustrate the kinds of information coded in this group.

** 87 other phrases were coded into this category, but are not described in the above table of the top 10 nodes for this category. Hence, the total represented here, 498, includes these data. The last 15% of the data coded, but not described in this table, were coded as Genie Out of the Bottle (n = 11), Humanitarian Interests (10), Farming Impact (9), Manipulation by Government (8), Rejection of Technology (7), Technology for the Rich (6), American Intransigence (5), Caution (5), Ethical Questions (5), Cost-Benefit Analysis of Monarch (4), Early Days of GE (4), Americans Uninformed (3), Free Market Regulation (3), Playing God (3), GE Food Takeover (2), Industry Consolidation (1), and Patenting Issues (1).

Regulation is an example of a problem definition; journalists or major stakeholders attribute a significant part of the *problem* to the regulation of GEOs in the United States and around the world. Indeed, most of the top ten nodes in this category (representing 85% of all the nodes coded here) deal with articulating the myriad problems associated with GEOs (as opposed to defining potential solutions): polarized views about the technology (most often represented by battle or conflict rhetorics, but otherwise by the notion of rising concern amongst Americans); manipulations or conflicts of interest associated with industry and government regulators; feeding an increasing world population in an environmentally friendly way; or the perceived public relations mis-steps by the agricultural biotechnology industry. *Solutions* to some of the most pressing problems presented by GEOs aren't highly represented in the top ten list of most-frequent nodes in this category. There are only two attempts at defining solutions that appear with any frequency: 1) defining agricultural GEOs as “substantially equivalent” to traditionally bred crops (and, therefore, preemptively concluding that they are safe), or 2) advancing a program of “serious science” to identify risks and mitigate them. In terms of dealing with the entire scope of risk issues, the notion of conducting cost- (or, risk-) benefit analysis is also explored to some degree (2%) as a solution to settle the debate of GEOs.

Regulation

The Regulation node was coded 207 times across 36 of the documents evaluated in this study and included a total of 41 sub-nodes, which were grouped into 14 broader sub-node categories (See Table 3.8). This problem definition category was the most complex of all the nodes addressed in this study, with many passages being coded to multiple sub-nodes in order to capture the nuances of this definition of the critical essence of “the problem” with GEOs that was uncovered by the Bt-monarch case. In fact, although the Regulation node itself was coded 207 times, a subsequent second-level coding of the data into sub-nodes to flesh out the nuances revealed nearly double the number (408) of sub-codes.

The most frequently coded and enduring (lasting throughout the entire time period of the case study) sub-nodes reflected 1) the differing opinions about how adequately (13%) or inadequately (26%) federal regulations were protecting human health and the environment from possible negative consequences of GEOs; 2) general descriptions of the U.S. regulatory/decision making processes (22%); or 3) comparisons between U.S. regulations and those of other countries or the international community in general (15%).

Table 3.8 Further Breakdown of the Regulation Sub-Node

Regulations Sub-node Breakdown	# Passages (% of Total)	Papers	Timeframe
U.S. federal regulations inadequate	107 (26%)	*NYT* & *WP*	5/99-9/01
U.S. regulatory trends	90 (22%)	*NYT* & *WP*	7/99-9/01
International regulations	61 (15%)	*NYT* & *WP*	6/99-7/01
U.S. federal regulations are adequate	53 (13%)	*NYT* & *WP*	5/99-9/01
More research is required	24 (6%)	*NYT* & *WP*	5/99-12/00
Regulations are burdensome	16 (4%)	*NYT* & *WP*	8/99-9/01
Food safety	16 (4%)	*NYT* & *WP*	8/99-5/01
Oversight of U.S. regulators	10 (2%)	*NYT* & *WP*	8/99-9/01
Public participation/information	9 (2%)	*NYT* & *WP*	11/00-9/01
Trusted regulations lead to acceptance	8 (2%)	*NYT* & *WP*	9/99-9/01
Regulation reduces risks	5 (1%)	*NYT* & *WP*	8/99-5/01
Patent Issues	4 (1%)	*WP*	7/00
Ag industry should assume liability	3 (1%)	*NYT* & *WP*	9/99-1/00
Funding/cost of regulation	2 (<1%)	*NYT* & *WP*	8/99-12/00
Total *	**408**		

* Note that this total doesn't match the number of phrases coded to the "Regulation" node (n = 207). This is because many of the phrases are coded to more than one sub-node to reflect the complexity of this problem definition (e.g., a passage discussing the complications that arise for export of GE crops to Europe, for example, would be coded in both the international regulations and regulations are burdensome sub-nodes).

The most prevalent description for "the problem" with GEOs is the lack of adequate regulation by the U.S. government (coded in 107 passages). The node was coded twice as often as the opposing node, that federal regulation for GEOs is adequate to protect human health and the environment. In general terms, a majority of the discussion centered on the notion that the U.S. regulatory system was insufficient to adequately protect public health and the environment. Eighty percent (80%) of the passages coded into the second-level sub-node of the Regulation Inadequate node expressed dissatisfaction, and even disillusionment, with federal GEO regulation or advocated for stronger federal regulations of the technology. Surprisingly, about 40% of the passages coded to this sub-node expressed disillusionment (coded when verbiage expressed more than passing dissatisfaction) with U.S. regulations, such as the December 1999 passage that *New York Times* Sunday magazine reporter, Michael Pollan, wrote:

> [The regulatory process] Sounds rational enough, until you discover that the F.D.A.'s ‘regulation’ of biotech is voluntary; companies decide for themselves whether to submit a new biotech food to the agency for review. In other words, the agency's oversight of biotech food has been *based less on law and science than on faith* (*NYT*, 12/12/99; emphasis added).

The other 20% of passages expressed skepticism about the industry’s role in regulating GEOs (i.e., the reliance on companies to self-disclose results of their in-house ecological risk assessments), the revolving door between industry and government regulatory agencies, and the perceived coercion of science that could result from the close industry/regulatory relationship.

The sources sponsoring the inadequate regulations point of view were often indirect attributions (e.g., “critics,” “consumers,” “environmentalists” or “researchers”). When more explicit attributions for the inadequacy frame were made, they were attributed most often to consumer and environmental groups, as well as to the research scientists from academic institutions who were conducting some type of GEO risk assessment research at the time of the Bt-monarch case (not necessarily monarch-related risk research, however).

Not surprisingly, the sources most typically sponsoring the opposing view—that GEO regulation is adequate—were the officials charged with regulating GEOs and the biotechnology industry itself. Frequently, this viewpoint was positioned within articles following a critique of the U.S. regulatory process, likely the result of the journalistic convention of balancing coverage of opposing points of view. Most often (more than one-third of the passages coded), U.S. regulatory officials were defending the decisions that their agencies made or were commenting on their perception that a high level of scientific examination went into regulatory decisions. Another third of the passages coded asserted that the U.S. regulations were very strong, especially in relationship to other countries (this node included adjectives attributed to U.S. regulators, such as "trusted" or "responsible").

In only one instance were environmentalists attributed to sponsoring the "adequate regulations" frame (*WP*, 1/16/00). In that case, the journalist was asserting that the EPA buffer requirement to delay insect resistance was considered by environmentalists as a "step in the right direction." Further down in the story, however, the journalist quotes Rebecca Goldburg, a scientist at the Environmental Defense Fund and then an NAS panelist investigating the environmental impact of GE corn, as saying "What EPA has done is to confirm that there are some serious environmental problems concerning the widespread planting of Bt corn." The quote, in the end, seems to contradict the journalist's assertion that the U.S. environmental groups believe that the government is moving toward "adequate regulation." At the time, in fact, some academic researchers were questioning the ability of the refuge concept to delay resistance (Glare & O'Callaghan 2000). But the example does point to a poignant tension within many of the articles, and to another major problem definition node (although much less frequent) that appears in 30 articles across the entire timeframe of the case study (from the first to the last articles in the study), Battle/Conflict Rhetorics.

Battle/Conflict Rhetorics

The Battle/Conflict Rhetorics node is one of the more interesting in the study, frequently pitting the United States (at least, its biotechnology industry, but oftentimes the country itself) against the world (particularly European countries), as well as the "anti's' against the pro-biotechnology industry and regulators. The node was coded 110 times, but there were also elements of the Battle/Conflict aspect of the story in the Conflict of Interest (12), Manipulation by Government (8), Technology of the Rich (6) and American Intransigence (5) nodes as well. Only three of the "battle/conflict" elements in these other references were explicit enough to also be coded in Battle/Conflict Rhetorics node as well. The others of them did not specifically fit the node definition: "Language that evokes the battle metaphor over GEOs. Also, language that perpetuates the 'newsworthiness' of the story as one in which conflict exists." While the battle/conflict node was less frequent than the regulation node, in 1999 it was more prominently featured than regulation—appearing in the lead paragraph six times vs. the regulation node's three lead appearances.

Of the 110 passages coded to this node, 92 had specific language used that evoked the war/battle metaphor; the others evoked the less-emotive "debate" or "controversy" in defining the social interaction of the story. The rhetorics used to promote the battle/conflict metaphor were varied, but frequently attributed the aggressor as the opponents of genetic engineering and the "embattled" as the industry (See Table 3.9).

Table 3.9 Categories of Rhetorics Used to Evoke Battle/Conflict Metaphor

Category	Examples
Battle Rhetorics	battle (5); rallying point (2); fracas; dispute (3); war/cold war (3); up in arms; skirmish; battleground; controversy; contest; fight (2); backlash (2); donnybrook
Battle Action	banish (2), invade, marching; leaping into the fray; pre-emptive salvo; wage a campaign (2); bully; retaliation; targeting (2); direct action; crusade; stifle debate; destroy (2); take on; combat; take a beating; sabotage; protect (2); defend (2); guerilla response; pounced; square off (2); heated criticism; mounted an effort; disrupt/disarray (2); seized; increased resistance; assail; attack (2)
Alliances	allies/alliances (3); co-conspirators; staunch supporters
Victory/Defeat	claiming victory; won; tide is turning against; gaining ground
Strategy	protectionism (2); conciliatory steps (2); imposing tariffs (2); creating a counterbalance; foreign policy; diffuse tension; timetable; slow to anger; stoke opposition; on the defensive (2); retreat (2); pressure; demand
Other	battle-hardened; hail/denounce; divisive; embattled industry

About 84 percent of the battle/conflict language coded appeared in the *New York Times*, compared with 16 percent in the *Washington Post*. The battle/conflict language sub-node was coded across 22 documents—only five of which were published in the *Washington Post*. Temporally, the battle rhetorics were evoked more often early in the story timeline, 88 percent of the rhetorics appeared in 1999 and the spring of 2000. And, the language used in the remaining references in the later part of the story (late 2000 and throughout 2001) were greatly tempered, using language such as "debate," "pressure" and “simmering dispute” in place of the stronger battle rhetorics illustrated in Table 3.9. Notably, most of the protesting that received media attention had also declined by this time, making the battle/conflict rhetorics less apropos.

Many of these battle/conflict rhetorics appeared very prominently in the stories. Seventeen passages coded in battle/conflict rhetorics node appeared in the lead paragraph of the story, and six headlines featured battle rhetorics (emphasis added):

- 1,500 *March* in Boston to Protest Biotech Food (*NYT* 3/27/00)
- Britons *Skirmish* over Genetically Modified Crops (*NYT* 8/23/99)
- Biotech Companies *Take On* Critics of Gene Altered Food (*NYT* 11/12/99)
- Two Sides *Square Off* on Genetically Altered Food (*NYT* 11/19/99)
- Talks Open on *Divisive Issue* of Gene Altered Food (*WP* 1/24/00)
- Biotech Food *Fight*: Two Sides *Square Off* at FDA (*WP* 11/19/99)

The protest element of the conflict was also featured very prominently, coded in 15 high-prominence passages—twice highlighted in headlines, once in a caption, and six times in the lead paragraph of the stories. The protest element of the conflict was also visually represented in 10 photos in the coverage with images of both street protesters (holding signs and dressed in street-theater costumes or hazardous materials suits) and destroyed test plots of GE corn. (Note that images were not counted in the textual analysis of the stories; See p. 142 for more information about photos and graphics used throughout the story coverage.)

In about 40 percent of the passages coded to this node, the battle was characterized as one between GE opponents versus GE supporters. The aggressor, or subject of the battle/conflict action was characterized as anti-biotechnology stakeholders, protestors and the general public in more than half of the passages coded where the conflict was characterized as one between GE opponents versus supporters. The biotech industry and GE proponents were only characterized as the subject of the battle rhetorics (or aggressor) in six instances; in about one-third of the passages, an aggressor was not clearly defined—the pro/anti conflict was presented more or less as one of competing claims. In all cases where the industry was the aggressor in the battle metaphor, it was because the industry was reacting to the opposition or protest movement or launching a new campaign against the "unfair attacks" by the anti-GE stakeholder groups.

Sixteen percent of the time (18 passages), the battle was characterized as one between the United States (and its biotechnology industry) and the rest of the world—particularly European nations. Four specific references to international conflicts were made in the early part of the story (1999 into early 2000), including two references to the cold war and one reference each to the Normandy invasion and the Balkans conflict. Where the battle was characterized as one between the United States and the rest of the world (either Europe specifically, or more generically the parts of the world unsupportive of GE crops), the aggressor was nearly equally characterized as the aggressive, fair trade-motivated United States or the "protectionist" European countries causing the "backlash" against GE crops. Europe was characterized as being "resentful" both of the U.S. biotechnology industry's progress in developing GE crops (*NYT* 6/27/99, 8/2/99) and of the potential that European farmers would "lose out" on worldwide biotechnology markets (*WP* 1/24/00).

Whether the battle was characterized as one between the U.S. and the world or as one between the "antis" and the proponents of GE, the rhetorics that indicated an emotive rationale for action were attributed to those opposed to the proliferation of genetic engineering (See Table 3.10 for examples). The only emotive description attributed to a pro-GE stakeholder in the coverage was when the industry was launching a campaign to address claims and concerns raised by "anti-GE" stakeholders. Thus, there appear to be some linkages between the public irrationality and emotiveness sub-node and the battle sub-node.

Table 3.10 Emotive Attributions to GE Stakeholders

Attributed To	Examples
"Antis"	• Focus of the *fury* against biotechnology(*NYT* 3/14/00) • WTO protesters *were angry* about gene-altered foods (*WP* 1/24/00)
Europeans	• Protests *grow more passionate* in Europe (*NYT* 3/14/00) • Resistance to labeling *rankles some Europeans* (*NYT* 3/14/00) • British media is *fomenting hysteria* (*NYT* 8/23/99) • An industry that already faced *widespread vilification* in Europe (*WP* 11/3/99)
U.S. citizenry	• Public *confidence is waning* (*NYT* 11/28/99) • Rising wave of *anti-biotech hysteria* (*NYT* 11/12/99)
Industry	• Novartis launched a *spirited campaign* to balance the flow of public information about biotechnology (*NYT* 11/12/99)

Bt / Biotechnology Definitions

Placed under this category were all of the nodes that described or defined the general background of GEOs, biotechnology, GE plants containing Bt, as well as the descriptors of the benefits and risks when they were used to help define genetic engineering or Bt for article readers. This category emerged as an important discursive element because how the technologies themselves were defined ultimately had an influence on how they were framed in the media discourse. Importantly, biotechnology is most often defined very explicitly by its presumed benefits to humankind (sometimes referred to as "genetic optimism"), which is consistent with other research findings about media reporting of genetic research. For example, researchers have found that both scientific and newspaper articles over-represent benefits and under-represent risks and ethical dilemmas associated with new genetic technology and research (Bubela & Caulfield 2004; Tammpuu 2004).

Of the 124 passages that were coded into nodes in this broad category (Table 3.11), two stood out in their frequency above the others: descriptions of the benefits of biotechnology (41%) and descriptions of genetic engineering or engineered Bt (36%). The benefits of Bt were also coded nine times (7%) in the articles, increasing the times "benefits" were defining descriptors to nearly half. The two newspapers also defined genetic engineering and engineered Bt by the acreage planted (12%). The most enduring of the definitions was the biotechnology descriptors node (more or less neutral definitions of the GE process), which was coded across 32 of the news articles in this study, spanning the entire timeframe of the case. The biotechnology benefits node was coded in 21 articles, and was also coded throughout the entire case study timeframe.

Table 3.11 Top Bt or Biotechnology Definitions Identified, By Frequency

Node	Description	Example*	#	% of Total
Biotech Benefits	Claims made about the benefits of biotechnology--real, realized, or proposed.	…biotechnology holds tremendous potential to provide safe and nutritious foods, to protect the environment and lower costs to consumers. (*WP* 6/14/00)	51	41%
Bt/Biotech Descriptor	How Bt or biotech or the process of genetic engineering is described. May include some discussion about GE in relation to traditional breeding methods as well.	The corn carries a gene derived from a bacterium, Bacillus thuringiensis. The gene produces Bt toxin, which kills a caterpillar called the European corn borer. (*NYT* 1/17/00)	45	36%
Acreage Planted	Claims about how many acres of GE crops are planted in the United States and world. May be used in some cases to illustrate the inevitability of a GE future.	For nearly a decade, genetically engineered food has been sold in the United States just like any other food. There are no labels telling consumers that their tortilla chips contain genetically altered corn -- about a third of the total crop -- or that almost all canola oil is made from genetically altered rapeseed. (*NYT* 2/9/00)	15	12%
Bt Benefits	Claims about the benefits of Bt-engineered crops.	Farmers may find it difficult to lay aside Bt corn. Previously, farmers had to scout their crops diligently for signs of corn borers and spray at just the right time in an infestation to kill them. Now they can plant Bt corn and let the internally produced toxins do all the work. (*NYT* 5/20/99)	9	7%
Biotech Handcuffs	Notion that the world has no choice but to accept biotechnology and biotech crops. Or, there will be little choice but to accept them as the way farming will be done in the future.	That sounds logical enough, but one hot question is whether farmers actually have much choice. Industry critics contend that the new technology has become so concentrated in the hands of powerful multinationals that they have the marketing influence with international aid agencies to force some products on farmers. (*NYT* 12/20/99)	2	2%

Absolute Necessity	Notion that there is no other way to feed the world and protect the environment except to adopt GE ag products.	Without gene modification technology, the report concludes, it will be impossible to feed the world's poor in the future without destroying the environment. (*WP* 7/11/00)	1	1%
Biotech History	Description of the history of biotechnology.	...Today such organisms [frost-resistant strawberry and Flavr Savr tomato] seem almost quaint as biotech salmon grow to market size in half the normal time and genetically modified goats make human blood proteins in their milk… (*NYT* 12/19/00)	1	1%
Total			**124**	**100%**

* The examples illustrated here were among the first in the list that appeared in a recall of all text coded to the node described, and are therefore from the earlier articles written on the subject. They are not meant to be representative of all the text coded in a particular node, but to illustrate the kinds of information coded in this group.

Biotech Benefits

The benefits of genetic engineering described in the news coverage fell broadly into five categories (described in decreasing prevalence).

1. ***Genetic engineering provides important tools for farmers that don't require extra effort/inputs at the field level (25 passages).*** Descriptions included pest resistant crops, virus resistance, herbicide resistance, ability to thrive in hostile environments, the notion of genetic engineering as the "new green revolution," and other assertions about how GE will advance (to the benefit of farmers) with a deeper understanding of crop genomes.

2. ***Genetic engineering will produce crops that are beneficial to human health (24 passages).*** Overwhelmingly, these descriptions described the

potential for genetic engineering to produce more nutritious foods (such as the so-called "golden rice," with increased vitamin A that could ostensibly prevent blindness when planted in developing countries). Other benefit claims included the ability to imbed vaccines into crop plants and even the possibility of curing cancer with the technology.

3. ***Genetic engineering will decrease the environmental impacts of current agricultural practices (20 passages).*** The most commonly cited benefit to the environment was the claim that GE crops would reduce the amount of pesticides and herbicides used by traditional agricultural practices. Other ecological benefits described included the notion of GE crops as being "cleaner" technology and one claim that GE would be "improving upon nature's work" (*WP*, 1/24/00).

4. ***Genetic engineering will confer market advantages to farmers and countries that choose to plant GE crops (18 passages).*** The market advantages described included increased yield, faster and stronger crop varieties, and economic efficiencies in the field (i.e., GE crops will be less expensive to grow than traditional varieties).

5. ***Genetic engineering has the potential to provide a host of other benefits to humankind and the environment (11 passages).*** There were also several general, non-specific claims of benefits in the media texts,

including descriptive adjectives (e.g., “potential benefits of genetic engineering are huge,” “enormous potential benefits,” “biotechnology holds tremendous potential”).

It’s important to note that of the GE benefits described in the coverage of the Bt-monarch issue, most were unrealized at the time, and the ones that were in the research and development pipeline largely fell in the “benefits to farmers” category (with the notable, and highly promoted exception of “golden rice,” whose development was funded by the nonprofit Rockefeller Foundation). Genetically engineered crops were, in fact, at a distinct *dis*advantage in international markets where the products required labeling; cost-reductions to farmers were then unrealized; and contemporary research did not support the notion that GE crops on the market were more “cost effective” (Benbrook 2001).

General Descriptions of the Technology

Bt Descriptors. Twenty-eight passages were coded to the Bt-descriptor sub-node—passages where journalists explained the complex technology to their readers. Passages within the sub-node were further broken down into 1) descriptions of the trait itself (i.e., that the corn was modified to kill corn-borers—“agricultural pests” that eat corn) and 2) descriptions of how the technology works (i.e., indicating that unique genetic material was used to produce a new trait in an agricultural product).

When it came to describing how the Bt trait itself worked, journalists more than twice as often employed the use of the more negative term of "toxin" (i.e., the plant either "carries" or "produces" a toxin) than the industry-preferred references of plant protection, pest resistance or the production of a "natural pesticide." There was also one passage that elicited extreme negativity—describing genetically engineered Bt corn as "butterfly-killing corn" (in a week-in-review column discussing Europe's aversion to genetic engineering, *NYT* 6/27/99).

In terms of describing the actual process of genetic engineering of Bt agricultural products, the journalists were quite vague. In the seven passages coded to this kind of technical description, the journalists mostly described the process as researchers either "engineering" (1) "giving" (3) or "endowing" (1) the plant with genetic material. Twice, the process was described more passively as the plants "contain" unique genetic material—not specifically addressing the active human role in transferring the material across species boundaries.

In short, when journalists defined the engineered Bt trait, they seemed to focus the notion of the "toxicity" of the GE crop (perhaps implicitly hinting of risk), while diminishing the human role in creating that risk. By contrast, journalists' descriptions of genetic engineering in the more general sense frequently called out the human role in transferring genetic material across species barriers.

Genetic Engineering Descriptors. Of the 30 passages coded to sub-nodes in this category, six called attention to the notion that genetic engineering is a new way to cross species boundaries. In describing this cross-species transfer, frequently journalists explicitly described the process as more precise (5 passages) than traditional breeding techniques or implied greater precision via word choices of "inserting" or "transferring" genetic material (6 passages). In only one instance did a journalist recognize the potential permanence of this human action, noting that the process was "permanently altering [the strain's] genetic code" in order to confer the sought-after trait. Otherwise, the descriptors tended to indicate a somewhat casual nature of the engineering—describing the process as "borrowing code" (3), "adding genes" (2) or "endowing" plants with a specific, desirable trait (2).

In only one article did a journalist describe in depth the various processes used to engineer agricultural crops via gene guns or agrobacterium (*NYT*, 11/3/99). A notable departure from other articles on the subject, in this case the newspaper presented significant coverage to the process using a large graphic to illustrate two primary methods for genetic engineering. The graphic, which was titled "A closer look: more than one way to alter a plant," spread across two columns of a full page devoted to a *NYT* special series, "Redesigning Nature." The graphic clearly intended to illustrate a level of precision with agrobacterium and gene gun transfer in the genetic engineering process. For example, the artists used directional arrows at increasing levels of magnification (of cells and double helices) to illustrate the presumed precision of the methods. The article series' title itself bolstered this notion of precision by evoking the purposefulness of "redesign." The article used valuable real estate, however, to address the problem of the "superweed threat," even evoking an improper incestuous interaction in a sidebar on the subject entitled, "When biotechnology crops and their wild cousins mingle." The overall takeaway message from the packaging of the article, graphics and sidebar seemed to be that humankind's design has a high level of purposefulness and precision and it is only when nature misbehaves that genetic engineering presents a problem.

In the final analysis, both GE crops and GE in general were overwhelmingly defined by their potential benefits to humans and their environment. Biotechnology descriptors throughout the case study articles also frequently positioned the technology as the inevitable next step in crop development through references to the technology by the number of acres *already* planted (15 passages), the crops' explicit and implicit *market worth* (66 passages), the *advancement* of crop science through genetic engineering (15), and the *absolute necessity* of the technology (3).

Risk & Safety Claims

With the central organizing components of the Bt-monarch case explicated—how the issue was shaped and defined through problem/solution definition, labeling and Bt/biotechnology definitions—I proceeded to hone in on how the notions of risk and safety were presented in the story. Into this broad category were placed all of the nodes that contained discursive symbols and devices used to explicate the risks from GEOs, which included safety arguments as well (Table 3.12). Throughout the Bt-monarch case, risks were broadly defined in myriad realms: environmental, economic, health/food, and global security. In some articles, where the Bt-monarch case was the focus of the story, ecological risks were discussed in considerable depth; in others, where the monarch was a secondary focus or only mentioned for illustrative purposes, the risks addressed by the media were wider ranging (i.e., included socio-economic and food safety risks as well). Far in front of the rest in terms of magnitude in this category were descriptions of ecological risks (39% of the total coded to this node). More moderately mentioned were references to economic risks (14%) and risks to the human food supply and associated health concerns (13%). If other sub-nodes that also addressed ecological risks are included—such as scientific uncertainty (8%), serious science (5%), generic safety arguments (4%), questionable science (3%), substantial equivalence (3%), threats not serious (1%), no evidence of harm (1%), comparisons to ecological tragedies (1%), and complexity of risk assessment (1%)—the actual frequency of risk/safety coverage related to *ecological* risks from GEOs is much greater (closer to 65%).

Table 3.12 Top 10 Risks and Safety Claims Identified, By Frequency

Node	Description	Example*	#	% of Total
Ecological Risk	Description or enumeration of any of the possible ecological risks from GEOs.	Research has shown that the pest-killing pollen can accidentally kill monarchs, though no one knows exactly how bad the problem is. (*WP* 7/9/01)	184	39%
Economic Concerns/Risk	Discussion of economic risks--to companies, farmers or nations--from GEOs.	The genetically modified corn was planted on more than 20 million acres last year and is worth hundreds of millions of dollars in seed sales annually. (*NYT* 1/17/00)	66	14%
Food/Health Safety Risk	References to consumer unease, arguments about	So far, there is no evidence that any of the genetically engineered foods now on the market have harmed anyone, or	60	13%

	food safety and risk, compromised nutritional value, the level of research conducted about food safety and allergies, and food regulation.	have much of an impact on the environment. (*NYT* 2/6/00)		
Scientific Uncertainty	Any description of the uncertainties of science in risk assessment or in description of risks from GEOs.	In remarks to reporters afterward, Mr. Haerlin dismissed the importance of saving African or Asian lives at the risk of spreading a new science that he considered untested. The Greenpeace position, he said, was that research could continue as long as no seeds or animals were ever released. (*NYT* 3/14/00)	38	8%
Serious Science	Notion that there has been a lot of serious scientific scrutiny of GEOs. Also, notions of safety because of perceived serious scientific scrutiny.	While Europeans fear the "G.M." label, scientists like Chris Somerville, a Stanford University plant biologist, say that genetic technology is "hundreds of times more predictable than traditional means" like cross-breeding plants or mutating seeds with radiation or heat. The fear of creating unpredictable monsters is "largely unfounded," Mr. Somerville added. (*NYT* 3/14/00)	25	5%
Generic Safety	Any claims that GEOs are safe in a general way--without significant qualification or quantification.	Dr. Val Giddings, vice president for food and agriculture at the Biotechnology Industry Organization, a trade group of hundreds of biotech companies, said, "This is a strong affirmation of the academy's previous reports and an emphatic reaffirmation of what the industry has been saying for years, that these products are safe and subject to more regulatory scrutiny than any others in history." (*NYT* 4/6/00)	21	4%
Questionable Science	Any suggestion that the science being used or cited is questionable in some way--either due to methods or conflict of interest.	Yet an American living in France cannot help but be aware that the European arguments against genetically modified plants (and hormone-treated beef), including scientific studies, are not being made widely available to the American public, perhaps because American scientists or food producers don't believe European science, dismissing it as self-interested. (*NYT* 8/2/99)	13	3%
Substantial Equivalence	Notion that GEOs are almost the same as traditionally bred crops and should, thus, be regulated as	A spokesman for the Grocery Manufacturers of America, Brian Sansoni, said his group is pleased that the report concludes that biotech and conventional foods are basically the	13	3%

	such.	same. "Hopefully, that will send a good message to Capitol Hill," he said. (*WP* 4/6/00)		
Comparison to Food/Drug Tragedy	Comparisons of GEO debate with previous debates or crises in food or medical safety (mad cow, etc.).	"These are the people who gave us thalidomide babies," Sarah Seeds, a protester who also trains others to protest nonviolently, said of the participants in the Bio2000 Convention. (*NYT* 3/27/00)	11	2%
Organic Farm Risk	The risks attributed to organic farming from GEOs--including financial damage, crop damage, third-world indigenous issues, contamination of fields, etc.	This measure is meant to slow the evolution of resistance to the Bt toxin, one of the few natural insecticides available to organic farmers. (*NYT* 1/17/00)	9	2%
Total **			**440**	**93%**

* The examples illustrated here were among the first in the list that appeared in a recall of all text coded to the node described, and are therefore from the earlier articles written on the subject. They are not meant to be representative of all the text coded in a particular node, but to illustrate the kinds of information coded in this group.

** 35 other passages were coded into this category, but are not described in the above table of the top 10 nodes for this category. Hence, the total represented here, 440, includes these data. The last 7% of the data coded, but not described in this table, were coded as General Risks (n = 7), Threat Not Serious (7), No Evidence of Harm (6), Comparisons to Ecological Tragedies (5), Costs of Risk Assessment (5), Complexity of Risk Assessment (4), and Other Risks to Monarchs (1).

Ecological Risks

A wide variety of ecological risks were addressed throughout the case study coverage (Table 3.13). There were also a number of more generalized references to "environmental" or "ecological" risks (25 passages) throughout the case study (notions of ecological risk that were not explained/detailed further by the journalist or information source cited). Also notable, 17 passages were coded as deeper explanations of risk assessment research. These deeper explanations were found in four articles in the case study, two in the *Washington Post*—describing preliminary research presented at the

Agricultural Biotechnology Stewardship Working Group symposium (*WP* 11/3/99) and details of the Jesse & Obrycki study (*WP* 8/22/00)—and two in the *New York Times*—explaining the Wolfenbarger and Phifer study (*NYT* 12/19/00) and describing the research to be released in the *NAS Proceedings* (*NYT* 9/9/01).

Non-Targets. The most predominant explication of non-target impacts was the discussion of the impacts of Bt corn pollen on monarch larvae (92 passages). Except for two cases, all other discussion (11 passages) of the potential risks to non-target species referred to risks to insects (the two exceptions simply referred to "non-pest species"). A couple of the passages recognized the specificity of engineered Bt—limiting the discussion of non-targets to "butterflies or moths," specifically referencing potential impacts to ladybird beetles and lacewings. In their discussion of the Bt-monarch case, journalists rarely mentioned the specificity of the larval diet, and frequently implied that the monarchs were eating the Bt pollen (rather than milkweed dusted with pollen). In only one-third (35) of the passages did the news account actually specify that either "caterpillars" (26) or "larvae" (9) were potentially being impacted by the pollen—all other references referred to the "butterfly." The lack of accuracy and depth in explicating the variety of non-target impacts possible, or potential species that could be impacted, is likely a reflection of editorial space limitations and the general lack of sophistication the media had in dealing with complex ecological relationships, or the nuances of this particular ecological risk assessment case.

Table 3.13 Ecological Risks Covered in Case Study Articles

Ecological Risk	Passages	% of Total
Risks to non-target species	105	50%
Evolution of “superweeds” or “superdiseases”	24	11%
Evolution of insect resistance (including “superbugs”)	16	8%
Unanticipated risks that are currently unknown to science	9	4%
Gene transfer to wild species or a general concept of “genetic pollution”	3	1%
Environmental risks that may continue, or worsen, if GE isn’t employed	3	1%
Soil damage or contamination	2	1%
Releasing wild species from ecological controls, such as disease	2	1%
Disruption or change in multi-trophic interactions	2	1%
Sub-lethal impacts	1	< 1%
Explanations of risk assessment research	17	8%
Generalized references	25	12%
Total *	**209**	

* This total includes some passages that were coded to more than one category. In particular, the 17 references coded to “risk assessment research” were nearly always also coded to another of the above categories.

Gene Transfer. In the case study, six articles (7 passages) explained the potential for gene transfer to wild relatives, and 11 passages (10 articles) the related potential to create “superweeds.” Most commonly, the concept was explained as the GE crops “interbreeding” or “cross pollinating” with “weeds” or “wild” versions of the same species. The passages described how the transfer of beneficial traits to wild relatives could enable such relatives to spread readily throughout their natural environment or be difficult to control in agricultural settings. Beyond the realm of agricultural environments, one article compared the potential of these superweeds to wreak ecological havoc akin to the kudzu vine or zebra mussels (*NYT* 11/3/99). In three instances, the concept was also referred to in a more amorphous way as “genetic pollution,” emphasizing the inability to recall “escaped” genetic material:

> The protesters who have destroyed test sites say letting them proceed would allow the escape of transplanted genes from crops to related wild species and contaminate the environment. (*NYT* 8/23/99)

Insect Resistance. In addition to the concept of superweeds, was the discussion of “superbugs,” or the potential for insects to evolve resistance to pesticides, like Bt, as the pesticide becomes more prevalent in the environment (16 passages in seven articles). The articles discussed how such evolution could be costly to farmers (in particular to organic farmers who use non-GE Bt as a “natural” pesticide) and make pest control more difficult in the future (perhaps requiring the use of stronger pesticides). In order to slow the evolution of resistance, the EPA required farmers to plant refuges of non-Bt corn in 2000 and requested that those refuges be planted on the edge of corn fields to also minimize the possibility of monarch larvae coming into contact with the Bt pollen. Because the refuge strategy was recommended to mitigate two potential ecological risks—non-target impacts as well as resistance evolution—the two risks were often mentioned together in case study articles.

General Descriptions & Unanticipated Risks. In 25 passages, the environmental risks of GE crops were described in more general terms. Most often, these passages were preceded or followed by more in-depth explanations of “environmental risk,” but not always. In the cases where the general descriptions of environmental risk were not further explicated, the article was usually focused on the food-safety, trade economics or regulatory aspects of the GE debate, rather than on the ecological risks.

Beyond the general descriptions of ecological risks was the notion or suggestion that there may exist some risks to the environment that have not even been considered yet by science. These unanticipated risks were mentioned in five articles in the study (nine passages). In two cases, the unanticipated risk was suggested with the genetic engineering process itself—the risk of trying to engineer a complex trait and achieving an unexpected result. In the other cases, the unanticipated risk was ecological. For example,

> The technology is still quite new, and some people worry that it hasn't been properly tested. They're especially worried that genetically engineered plants and animals might change the environment in ways we don't yet understand. (*WP* 5/30/01)

Risk Assessment Research. Four articles contained 17 passages that were coded as deeper explanations of risk assessment research. These passages went beyond simple identification of potential ecological risks, and in some way further explicated the more comprehensive aspects of risk assessment. Perhaps the first event deemed "newsworthy" enough to cover the comprehensive risk assessment underway was the ABSWG symposium to discuss the preliminary research findings of the multiple studies launched to assess risk during the summer of 1999. The *Washington Post* article about the symposium (11/3/99) highlighted the studies' preliminary findings that the exposure appeared to be low because the overlap of pollen production vs. caterpillar feeding did not correspond in several regions of the country, and oftentimes milkweed in and around corn fields did not have enough pollen on its leaves to be toxic to the caterpillars. The headline of the article reflected the overall “reassuring” tone of the article: “Gene-altered corn’s impact re-assessed: Studies funded by Biotech Consortium find little risk to monarch butterflies.”

By contrast, the two articles published in 2000 that delved into comprehensive ecological risk assessment had a decidedly more concerned tone. The August 2000 *Washington Post* article describing the Jesse & Obrycki modified field study quoted Obrycki as saying his research was “taking the monarch research a step further” with his findings that 20 percent of the larvae in his study died from Bt pollen exposure. In addition to the Jesse & Obrycki findings, the article included extensive discussion of the other ongoing risk assessment research at the time and the data that were missing from the original Losey, Rayor & Carter (1999) laboratory research, which needed to be gathered to accurately assess the actual risk to monarch larvae in the wild. The article presented the Jesse & Obrycki research as a key piece—and not an encouraging one—of the missing data. The *New York Times* also highlighted the concerns raised by the Jesse & Obrycki findings and other preliminary research findings from Minnesota and Iowa, presenting them all in light of the December 2000 Wolfenbarger & Phifer critique of pre-commercialization risk assessment research for GE crops in the United States (*NYT* 12/19/00). The article also highlighted the broader complexity—and hence, the massive cost—of comprehensive ecological risk assessments. The article contextualized the single-species risk assessment framework used in the Bt-monarch case within the broader context of complex ecological systems and the multiple other risk factors present when researchers consider complicated ecological systems and species interactions. The December 2000 articles also articulated the difference between peer-reviewed risk assessment efforts vs. the in-house risk assessments from biotech companies, which are rarely published in peer-reviewed journals.

Finally, the *New York Times* described the results of the Bt-monarch risk assessment research to be released in the *NAS Proceedings* (9/9/01). The article headline "New research fuels debate of genetic food altering" and lead suggested that the NAS findings were far from decisive and that the debate was "far from ended" on the toxicity of Bt corn to monarchs. The article went on to explain the findings of the NAS papers, and why, even though the comprehensive risk assessment ultimately concluded that Bt corn did not pose a significant threat to monarch butterflies, there were still lingering questions due to the issue of whether or not the pollen in the research studies ought to have been "purified" to exclude other plant parts (anthers).

Safety Claims

The newspaper coverage also reported the industry and U.S. regulatory claims that GEOs were "safe" for the environment and human health 47 times throughout this case study. Twenty-one (21) passages were coded as making "generic safety" arguments, claiming safety, with little or no qualification on the level of research done to make that determination. These passages were coded in 11 media articles throughout the case study coverage—from the summer of 1999 (an article which does, incidentally mention that "there is not enough data to verify that claim," *NYT* 8/16/99), until the very last article in the case study ("finding the gene-spliced crop posed no risk to monarch butterflies, birds and animals or human health," *NYT* 10/17/01). Such claims were most often made by BIO or biotech company spokespersons (9 attributions), but were also made by journalists and op-ed writers without attribution (4 passages) or as an interpretation of the NAS report in April 2000 on plant-incorporated protectants (5 passages). Government regulators were cited as making the claim twice (2 passages), and the claim is once openly critiqued by LaReesa Wolfenbarger ("Some of these questions are very elusive, but that doesn't mean that we stop studying them or make sweeping generalizations about them," *NYT* 12/14/00).

Besides the generic safety claims, newspaper reportage also included safety references emphasizing the regulatory system's position that GE crops were "substantially equivalent" to traditionally bred crops (13 passages, two of which were critiquing the assertion), that they posed "no serious threat" (7 passages), or that no evidence of harm yet existed (6 passages, one of which mentioned that "few safety studies have been done," *NYT* 9/8/99).

Viewed in its entirety, the scope of the ecological risks covered in the case study articles was a fairly comprehensive, albeit cursory (necessarily), treatment of the potential ecological risks from GE crops that were known at the time. A consistent and critical reader of these newspapers would gain a fairly comprehensive view of potential ecological risks from the case study the coverage. It's possible that the broader reportage of risks made the assertion of generic safety arguments less plausible to readers through time. For example, the blanket assertion of the safety of all GE products is made only once in case study articles after December 2000 (*NYT* 10/17/01, the statement was attributed to the EPA renewing permits). However, prior to that final reference, the last reporting of a "generic safety" claim *by industry* was made in the *New York Times* article discussion of Wolfenbarger & Phifer's literature review of peer-reviewed risk assessments (*NYT* 12/14/00), which was challenged by a quote from Wolfenbarger (see above). The FDA determination of "substantial equivalence" in food products, of course, was described throughout the entire coverage of the Bt-monarch case; the last reference was late in the case study coverage in a "KidsPost" article, next to a prominent image of biotech "super veggies," (*WP* 5/30/01).

Images & Illustrations

The Bt-monarch story was also constructed by the images used in the *New York Times* and *Washington Post* throughout the timeframe of the case study. All told, 48 images helped emphasize elements of the story, and in doing so, promote the cultural symbols used to define and frame the issue for the general public. Table 3.14 overviews the kinds of images and illustrations the newspapers used to tell the story.

Newspaper framing studies usually focus on textual content analysis. Increasingly however, attention is also being given to the influence of images on the "priming" of media audiences for certain frames, particularly with regard to racial stereotyping and political positioning (Abraham & Appiah 2006; Grimes & Drechsel 1996). Gibson &

Zellmann (2000) found that the information contained within photographs significantly influenced the reader's perception of the issues addressed in the story, even if that information is not directly relevant to the story itself (e.g., "incidental" information, such as race). Culbertson (1969) found that adding artwork illustrating the "pro" or "con" stand of a pro-con argument made that side of the argument more salient with audience members (as cited in Wanta 1988). Gibson & Zellmann (2000) have also shown that reader/viewer retention of text-related information is greater when the text has an accompanying image, and Wanta's (1988) research demonstrates that the readers' attention to a story is greater when a single, large photograph accompanies it.

Table 3.14 Images & Illustrations Used in the Bt-Monarch Media Coverage

Category	Subject of Image/Illustration	#
Photo: Protest	Protesters (11); Vandalized corn field	12
Photo: Monarchs	Butterfly (5; one also showed chrysalis); Caterpillar (3)	8
Photo: Farming	Farmer (3); Farm or field (2); Corn crop (1)	6
Art: Promising Science	Double helix/plant juxtaposition (3); double helix (1); ear of corn in test tube (1); Tomato/corn superheroes (1)	6
Photo: "Experts" giving testimony	USDA secretary, Farm journalist, Grocery representative; Unidentified FDA panelists; Jeremy Rifkin ("biotech critic")	3
Photo: Stakeholders	Consumer in store (2); Developing world poor (1)	3
Photo: Science	Flower in beaker (1); Field test (1); Rodin's "Thinker" (1)	3
Art: Dangerous Science	"Mad" scientist with face-mask and bubbling beakers standing in field of dead crops (1); ear of corn as spear (1)	2
Graphic: Monarch	North American map of corn belt and migration routes of monarchs (same map, published twice)	2
Graphic: Farming	Economics of U.S. farming	1
Graphic: GE Foods	Photos of food products with charts illustrating percentages of U.S. crops that are genetically engineered	1
Graphic: GE	Illustrations of different GE methods	1
Total		**48**

* Highlighted rows make specific visual statements about genetic engineering. See discussion below.

The Bt-monarch story was perceived by newspaper editors as prominent enough to warrant illustration in both 1999 and 2000, but not as much in 2001. Of the 48 images used in the story as it progressed through time (35 in the *NYT* and 13 in the *WP*), only two illustrations appeared in early 2001—one cartoon of "super veggies" in the kids section of the *Washington Post*, "KidsPost," and one line-art image of an ear of corn in a beaker used to highlight a *Washington Post* staff editorial on GE foods. In 1999 the papers printed 28 images to illustrate the story, and in 2000 they published 18—a predictable decrease in the perceived prominence of the story as it unfolded through the media issue cycle (Downs 1972). Most of the images used were produced in house by the newspapers—from staff photographers and stringers, or from the newspapers' art departments (54% in the *NYT* and 76% in the *WP*). New service images (Associated Press, Reuters and Agence France-Presse) were used for 34% and 15% of the visual images in the *NYT* and *WP*, respectively. The concern raised by Paterson (2001) about the homogenization of television news images by the proliferation of news service images, appears to have played a lesser role in the present case study of newspaper images.

Protest and Conflict

The most common images used in the media coverage were photographs of protesters, representing one-quarter of all visual representations in the *NYT* and *WP* during the first two years of the story (1999-2000), and promoting the battle/conflict element of the story during the timeframe of the most active protesting against genetically engineered food. Protesters were not pictured in any of the stories in 2001. Most commonly, the protesters were pictured in the streets demonstrating outside of regulatory hearings and scientific panel meetings; in two cases the images were of protesters in agricultural field settings.

Many of the photos pictured close-ups of the signs and t-shirt slogans adorning the protesters, which included messages advocating for a moratorium on GE product development and the labeling of GE foods; the “Frankenfood” and “mutant corn” word play; and warnings of the perils of globalization, big business, and the “revolving door” between industry and scientific panels studying the safety of GEOs. Imagery included skull and crossbones; unlikely combinations of plants and animals (e.g., a strawberry crossed with a fish); people dressed in hazardous material suits and face masks; street theater actors in costumes; and a vandalized field plot of GE corn. One Associated Press image appeared in both newspapers in November and December 1999. The photo was of a street theater actor dressed as a corn cob with a skull and crossbones on the ear above the letters “Bt.” Instead of a corn husk, the ear of corn was emerging from a body bag—the emphasis clearly on the human health aspect of the controversy.

Greenpeace was the only protest group logo easily recognizable in any of the photos. Without exception, the photos of protesters were close-ups, giving little or no perspective on the actual size or number of people involved in the protests. In only one case was the protester in the photograph identified by name in the image’s caption. This journalistic practice had the practical effect of objectifying the activity in the photo by not naming the subjects or their particular concerns—thereby de-legitimizing them. As a collection of visual images, the protest photos emphasized what Hertog & McLeod

(2001) call a “circus frame,” which emphasizes differences in the subject from mainstream society, or “oddity,” instead of the subject’s “critique of society” (p. 157). As challengers to the status quo, they appear to suffer from what Stinchcombe (1965) called the “liabilities of newness,” which can be, “obstacles to even the most logical ideas, especially if they are reinvigorating a debate that appears to have been settled in the field for some time” (as cited in Proffitt 2004, p. 58).

Monarchs

The second most common image was the monarch itself—most commonly the brilliant, bright-orange and black adult butterflies (not the stage impacted by the Bt toxin) but also the caterpillar and chrysalis life stages. Most frequently, the butterfly was photographed with wings outspread, perched on vegetation or with wings folded together perched on or hanging from vegetation. The images were always close-ups, and never illustrated the butterfly in flight. This apparently “inactive” posture—intentionally or not—emphasized the position of the monarch butterfly in the story as a beautiful creature that a human action was potentially harming—an innocent casualty.

The monarch image appeared only three times in 1999—twice as the butterfly and once in the caterpillar form. The *Washington Post* also published a map from the World Wildlife Fund illustrating the butterfly’s North American migration route juxtaposed against the U.S. corn belt in November 1999 (and republished in August 2000). The butterfly appeared five times in 2000: three times as a butterfly, once as a chrysalis and once as a caterpillar.

In one case in December 2000, the caterpillar was pictured next to a field test at the University of Minnesota, where researchers were taking measurements in a cornfield test-plot to determine how abundant milkweed plants were inside the cornfields (*NYT* 12/19/00). This was the only instance in the case study newspaper coverage where the heart of the case was actually illustrated accurately: the subject being the *caterpillar* life form and the *corn-field milkweed plants* as the actual sight of the alleged problem. Even the *Washington Post's* maps of migration routes, though likely an attempt at mapping the location of the problem, didn't accurately illustrate the issue—as the U.S. corn belt was not overlaid with the breeding range of North American monarchs. While the map was successful in bringing forth the complicating factors of monarch conservation—the destruction of its over-wintering grounds in Mexico—the map failed to accurately visualize the problem under investigation—threats to the species in its target breeding areas.

Major Stakeholders

Farmers, consumers and the developing world poor were the major stakeholders represented by the imagery of the Bt-monarch case. In the case of farmers, two were U.S. farmers standing in their fields of corn and squash, respectively, and one was a British farmer standing in a field he had planted with GE rapeseed, to which he was anticipating protests or vandalism. All of the farmers where pictured close-up and identified by name and the geographic location of their farms. Temporally, all of the photos of the farmers—and the graphic depicting the plight of the American small farmer—were published in 1999, when there was considerable emphasis on how the EPA regulations on Bt corn plantings might impact farmers who had planted (or planned to plant) GE corn in 1999 and the spring of 2000. The message sent by these media illustrations was clear; the potential negative impacts from Bt corn on monarch butterfly larvae must be weighed against the heavy wait regulating or banning these GE organisms will have on small farmers.

Another major stakeholder group represented in the newspaper imagery and graphics was consumers. Two photos (one of a shopper in the aisle of a grocery store and one of a consumer exiting a grocery store) and one graphic (picturing common U.S. products that may contain GE ingredients), represented this stakeholder group in the media story about the risks of GEOs. Here, the issue represented in the imagery was of the consumer's right to know what he/she was eating. One February 2000 article in the *New York Times* juxtaposed a British consumer leaving a neighborhood grocery store with a product label identifying one ingredient as "genetically modified" (*NYT* 2/9/00, pg. F5). The consumer was passing by a sign in front of the store that announced that the store had removed GM soya and maize ingredients from products packaged under its store label. Another graphic illustrated common U.S. products that "may contain" GE ingredients (e.g., Oreo cookies, Cambell's soup, and Coca-cola) juxtaposed with pie charts illustrating the percentages of corn, soy and cotton that are GE in the United States (*WP* 8/15/99).

The promise of biotechnology was also represented in one article with a photo of the developing world's poor, considered another primary stakeholder in the GE debate. The image was taken from a Du Pont television commercial featuring GE products as a way to help the hungry in the developing world. Pictured were two women squatting next to a stove, apparently cooking rice. The caption read that Du Pont was promoting the message with its commercials that biotechnology would "make food grow where food can't grow" (*NYT* 11/12/99). Just below the photo was a much smaller line-art illustration of a proposed label for genetically engineered food. Again, the clear message in the juxtaposition was that Americans must weigh the consumers' "right to know" what they are eating with the potential for humanitarian biotechnology to help the world's malnourished.

The "Experts"

Three photographs of "experts" were used in the newspaper coverage of the Bt-monarch case. Of the eight people pictured in these three images, seven represented government, media or industry stakeholders and only one, Jeremy Rifkin, was described as a "critic of biotechnology." The "experts" were all wearing suits (all men, except one) and appeared in a boardroom or public hearing setting. The experts, for the most part, were identified by name and affiliation; in sharp contrast to the mostly anonymous protesters portrayed in other stories. In the case of one image of panelists gathered at an FDA hearing in Chicago in November 1999, the two panelists photographed were not identified by name, but were clearly identified as representatives of the FDA in the caption and body of the article.

Legitimizing symbols in these photos included hearing room tables, microphones, an American flag (in the frame behind USDA Secretary Dan Glickman) and people dressed in business attire. Notably, except for the one photograph of "biotechnology critic" Jeremy Rifkin, none of the well-credentialed, university or non-governmental scientists that provided testimony to scientific panels or at governmental hearings were pictured in the stories. The lone photo of Rifkin was the only representation of "legitimized dissent" in a formal setting. Besides being a "biotechnology critic," Rifkin is founder of the Washington DC Foundation on Economic Trends, author of several books on the impacts of technological changes on the global economy and environment, a Wharton School lecturer and political advisor on globalization to several countries in the European Union.

Images of Biotechnology

While certainly all of the above-highlighted imagery adds meaningfully to how the science of genetic engineering is framed in a broader social and cultural way, a dozen of the images that appeared in the case study newspapers visually elicit very explicit messages about the practice of genetic engineering (See highlighted lines in Table 3.14). In the general news segments where illustrations and photos appeared, the overtone from the images is that genetic engineering is an important and potentially powerful science. The use of a *New York Times* (11/3/99) graphic to describe the different methods of genetic engineering, for example, is described at length above (See p. 125).

Perhaps the most intriguing image appeared in the second article in the case study, juxtaposing Auguste Rodin's "The Thinker" with a sunflower growing from a beaker (*NYT* 6/24/99). "The Thinker" is positioned on the page as if he is looking down upon the odd flower and contemplating its meaning. The graphic was entitled, "Contemplating the year 2030 problem," and ran in conjunction with the article, "Plotting corporate futures: Biotechnology examines what could go wrong," about Monsanto's scenario-building exercise. The graphic appeared above a photo of Jeremy Rifkin testifying at Monsanto headquarters (described above). The implicit message in the visual was unmistakable: proceed with caution and serious contemplation.

The most common portrayal of genetic engineering as a promising science was the use of the double-helix imagery. The image was often used to highlight a GE story on the newspaper page and was positioned with revered placement: as a core of an apple held between the thumb and forefinger—as a scientist would up a beaker to the light to examine its contents (*WP* 6/14/00); wrapped around an ear of corn to highlight a headline on the page (*WP* 8/15/99); or along the full column length of a story about the technology to highlight a story about how genetically engineered plants would soon be available for home gardeners, forcing home gardeners to "confront the politically charged issue," (*WP* 1/27/00, p. T14). A line art image of a corncob in a beaker was used to highlight a *Washington Post* staff editorial extolling the benefits of genetic engineering for the developing world's poor (*WP* 7/9/01).

Also in the realm of "promising science" imagery was the superhero tomato and corn cartoon that appeared in conjunction with an article about GE food in the kids section of the *Washington Post* ("KidsPost," *WP* 5/30/01). The KidsPost is an attempt to make current events stories accessible to younger audiences. Here superhero vegetables were called out on the page with a starburst graphic—complete with bulging muscles, capes, superhero belts and eyemasks (see the actual image on p. 202). The associated article explained how genetic engineering can make plants "stronger" and "give food more of the qualities that consumers want," (p. C15) and went on to explain why some people don't want their food genetically engineered.

Most of the above-described images of genetic engineering as a *promising science* appeared in the *Washington Post*. Imagery that suggested genetic engineering might be a *dangerous science* only appeared twice in the case study coverage—both times in the op-ed and editorial pages. The first was a political cartoon depicting a wide-eyed, mad-scientist scarecrow in a field of dead or dying crops (*NYT* 8/2/99). The scientist was holding two bubbling beakers and wearing a white lab coat and facemask for protection; his expression was one of bewilderment. The cartoon appeared in conjunction with an Op-Ed, "France's fickle appetite," which was critical of the U.S. regulatory system for GE crops and asked in a first-column pull-quote, "Why the war over genetically altered food?"

The other "dangerous science" image was a line-art graphic (*WP* 8/31/00) of a dagger-shaped ear of corn, being held by a hand as if the ear is going to be stabbed into something/someone. This "dangerous science" graphic appeared above the title "Bt corn and the butterflies," which highlighted three separate letters to the editor that represented a range of opinion about the Bt-monarch case—one from a former EPA official who is "convinced that [biotech crops are] very beneficial to the environment;" one from an environmental advocate from U.S. PIRG suggesting that the biotech industry should "stop running away from peer-reviewed science;" and one from a reader clarifying how the Bt toxin in GE crops works.

On the whole, the collection of images, photographs, artwork and graphics presented in the newspaper coverage of the Bt-monarch case tended to heavily emphasize the battle aspect of the story. The conflict was mostly visually illustrated through the predominantly placed protest images (12), but was also highlighted in the interesting collage of contrasting images of science itself—GE as a "promising science" (7) vs. a "dangerous science" (2) or a science of which Americans ought to be wary (3).

Sources and Attributions

Counts were conducted of all the sources used by journalists in the Bt-monarch case study coverage—both direct quotations and paraphrased statements attributed to named individuals, groups and recognized social sectors (Retzinger 2001). NVivo was used to organize the sources into broad categories for analysis.

The use of sources to define where the media obtained their information about genetically engineered organisms, and the Bt-monarch case in particular, came from both *direct* attribution of the information to a specific source and *indirect* attribution of information to a non- or less-descript source. To illustrate the difference, consider the two attributions that follow (emphasis added):

> (1) But *Dr. E. William Colglazier, the academy's executive director*, said the academy stands behind the study. The academy conducted an internal review of the accusations that Mr. Kucinich had made about the conflicts, *Dr. Colglazier* said, and found that the panel "meets our standards of scientific quality, evidence, objectivity and independence." (*NYT* 4/6/00)

> (2) The plants carry foreign genes taken from the viruses that confer protection against the disease. *Ecologists* have expressed concern about the potential for such plants to interbreed with wild plants, conferring virus resistance and creating a super weed. (*NYT* 4/6/00)

The first example (1) was a direct attribution of information; the National Academy of Sciences, as represented by its executive director, is standing behind information presented by one of its scientific panels. The journalist had actually interviewed Colglazier for comment to directly attribute—through quotation—the NAS's support. For the purposes of this research, the attribution was coded as a direct source, and eventually grouped under the sub-nodes of "Academic" and "NAS." In the second example (2) the information was described as broadly representing a professional group's interest in the GE debate. In this case, the source was coded as an indirect source, and then grouped into the "Generic Researchers/Scientists" sub-node.

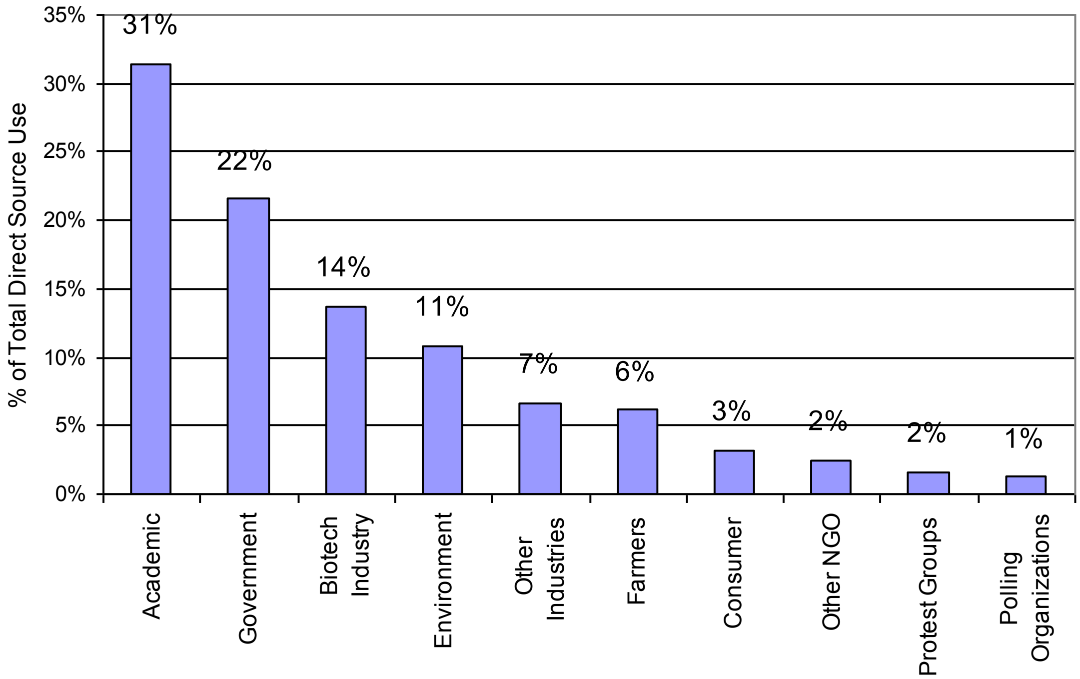
Media studies have long recognized the prominence of government and private sector officials in media coverage (see the oft-cited Gans 1979, 2004; Shoemaker & Reese 1991). Previous studies of media coverage of genetically engineered organisms have found that journalists are less likely to question the motives of "scientific" sources than political or business sources, despite the fact that today some scientists are now highly subsidized by corporate interests (Priest 1999; Retzinger 2001; Tammpuu 2004).

Like Retzinger (2001), I found that government and business interests were "normalized" and cited most frequently as representing, at least symbolically, the national dialog about GEOs in the Bt-monarch case study (Figure 3.5). Thirty-one percent (31%) of all direct sources were attributed to academic sources in this case, followed by government (22%), biotech industry (14%), and environmental (11%) sources. University-affiliated scientists were cited less frequently in the Retzinger study than the present one, likely due to the prominent role that higher education institutions played in the large-scale risk assessment that emerged following the Cornell study. Little direct attribution was awarded to consumer (3%), non-governmental organizations (2%), protest groups (2%), or polling organizations (1%) in the Bt-monarch case study, also consistent with Retzinger's (2001) findings.

Direct Sources

Academic Sources. Within the Academic Sources sub-node, the National Academy of Sciences was the most oft-cited source of information (51 references across eight different news stories), followed by John Losey and his Cornell colleagues (21 references across 10 stories), and John Obrycki and colleagues from Iowa State University (12 references in four stories).

Figure 3.5 Direct Use of Sources in *NYT* and *WP* Coverage



Note: A total of 528 sources were coded as direct sources throughout the case study.

The NAS was most frequently cited following its April 2000 report (NRC 2000), which "cautiously supported" the safety of biotech foods that were already on the market and recommended more scrutiny of potential environmental impacts from GE crops. The Committee on Genetically Modified Pest-Protected Plants was made up of eight university professors, an intellectual property lawyer, and one representative each from an environmental policy group, a biotechnology consulting firm, and the California Environmental Protection Agency. The NAS was also heavily cited in the reporting of the risk assessment research findings in September 2001. In addition, the Academy was prominently featured in 1999, when a lead researcher from a biotech risk panel left NAS for a job with BIO. In general, the NAS was most often portrayed as a supporter of GE crops and the notion that the crops would be necessary to feed the growing human population, with the caveats that 1) more environmental risk research was needed and 2) the biotech industry should focus more of its energies on meeting the needs of people in the developing world.

Thirty-seven (37) other academic researchers were directly cited throughout the case study coverage. Of those, most were ecologists or evolutionary biologists (11) or entomologists (9). Plant and soil biologists (4), food safety specialists (3), agricultural economists (2), biotechnology researchers/molecular biologists (2), a college dean and a law professor were also represented (four other "academic" affiliations were implied, but specific disciplines never directly stated). Consistent with Tammpuu (2001), academic researchers and "establishment scientists" were used by journalists to explain, or provide context for, the major scientific findings throughout the case study.

Losey and his colleagues were the most often-cited academic researchers in the case. In the early references to Losey, Rayor & Carter (1999), the source attributions were fairly straightforward, labeling the researchers as "Cornell researchers" and matter-of-factly referencing the research findings. As the Bt-monarch case progressed, however, other editorial attributions were added to the references of the Cornell research group, such as

- a reference to the research that was "attacked by other scientists" (*WP* 8/22/00);
- "a finding that caused some to criticize the widely used products and the government regulators who approved them," (*WP* 9/17/01); and
- Research that "triggered widespread concern by suggesting that pollen …may be killing the popular insects," and "raised the specter of windblown pollen killing beneficial insects…as well as popular creatures like the monarch…" (*WP* 11/03/99).

Other often-cited academic researchers were John Obrycki and his colleagues from Iowa State University and LaReesa Wolfenbarger and Paul Phifer, of the EPA and State Department, respectively. Both sets of researchers presented contrary viewpoints to the *prevailing* research assertions during the case study that 1) the monarch risk assessment was showing that monarchs were relatively "safe" from Bt corn pollen and 2) that the U.S. regulatory framework was adequate to protect human health and the environment. Obrycki and colleagues were reporting on their field results of lethal impacts from unpurified corn pollen on monarch larvae (the pollen contained anther parts, which are found on within-field conditions on milkweed) (Jesse & Obrycki 2000). Wolfenbarger & Phifer (2000) critiqued the U.S. regulatory system in a widely cited article that was published in the journal *Science*.

The findings in this research are consistent with previous research on how scientific sources are used by the print news media, with a focus on "establishment" scientists, rather than "independent scientists" and relatively less emphasis on public sources and their values and concerns (Anderson 2002, Peterson 2001). The voices of ordinary citizens were found to occur with less frequency in newspaper coverage of the Bt-monarch case, and offered more of a "symbolic presence" in terms of representing the "human angle" that balances the "expert discourse" offered by scientists (Anderson 2002, p. 332).

Government Sources. The U.S. Department of Agriculture was the most-cited direct source in the Government sub-node (47 attributions total), with the USDA Secretary Dan Glickman cited directly 19 times in the coverage of the Bt-monarch case. Most frequently, the USDA was used as a source explaining its decision process (6 attributions) or regulatory processes (8 attributions) regarding GE crops. The agency, and Glickman, were also sought and cited for statements that minimized the risks to human health or the environment (7 attributions) or to advocate for more funding and risk research for GE crops (6 attributions). In addition, the agency provided statistical information in the articles (5 attributions) and commented on issues regarding the plight of American farmers (3 citations) and international trade issues / policies associated with GEOs (6 citations).

The EPA was the second-most cited direct government source (25 citations) of information, although no single representative from the agency was prominently featured. The agency was most often used to explain regulations (especially those associated with the voluntary buffer of non-GE corn) or the EPA's decision process (11 citations), but also to comment on newly emerging research on the environmental risks from GE crops

(14 citations). Many of the references were to the draft EPA report released in September 2000, which suggested there were no risks to monarch larvae from Bt corn pollen (U.S. EPA, 2001).

Elected officials were cited 12 times in the case study—most prominently Representative Dennis Kucinich (D-Ohio, 6 citations), who was noted for his public criticism about the biotech interests represented on the NAS panel, as a strong supporter of labeling GE foods, and once labeled as an "anti-genetic activist" (*WP* 7/9/01). Other elected officials cited included "the Clinton Administration" (3 citations), senators Tom Harkin and Richard Lugar, and the "House Science Committee."

Biotechnology Industry and Company Sources. Novartis, Monsanto and DuPont took the lead for sources representing individual biotechnology companies in the case study coverage. Individual biotech companies were cited directly 35 times, while the primary industry organization, the Biotechnology Industry Organization (BIO), was cited directly 26 times. Val Giddings (Vice President for Food & Agriculture) and Michael Phillips (Executive Director) were the most cited representatives of the industry for BIO.

When cited directly, industry and company representatives were most frequently either questioning new research studies that highlighted ecological risks or critiquing policies that they perceived might negatively impact the industry. In only one instance did an industry representative indicate support for further ecological research, and in that case only with the caveat that "the public should not look to the private sector to foot the bill" (attributed to Michael Phillips of BIO, *NYT* 12/19/00). On the other end of the spectrum, pro-industry advocacy groups were also cited seven times in the case defending the biotechnology industry and once accusing the opponents of Bt corn as wanting to "…take away our choice. They want to put worms back in the food," (attributed to William McLeod, a former director at the Federal Trade Commission and lawyer working with the Alliance for Better Foods, *NYT* 11/19/99).

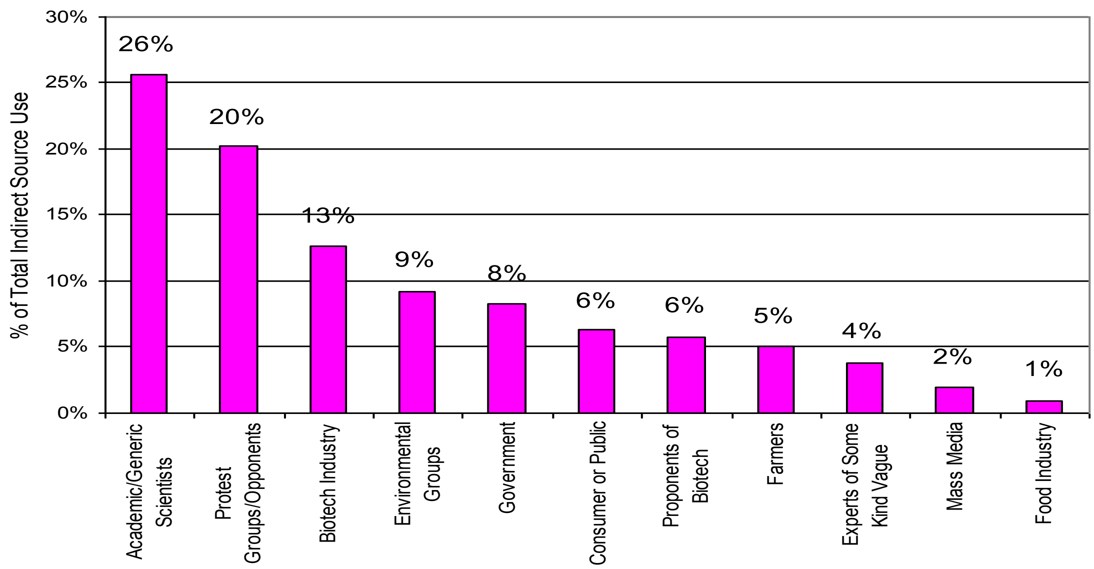
Individuals from biotechnology companies were most often called upon as sources to critique or minimize the significance of new research findings—most often arguing that the newer peer-reviewed findings were in contradiction with the pre-commercialization research they had conducted themselves. The companies were also used as sources to explain how the companies and industry were defending themselves against the negative public opinion arising from the monarch case (Novartis and Monsanto were most cited on this aspect) and to highlight the impacts of the negative public opinion on the companies' financial status or future markets.

Indirect Sources

Of the 316 indirect sources coded in the case study coverage, generic "scientists" and "protest groups" (or, "opponents" of biotechnology) were the largest nodes (Figure 3.6). Journalists were more likely to *indirectly* reference sources (rather than provide *direct*, specific attributions) if the sources were perceived to be situated on the ends of the public opinion spectrum—either biotechnology proponents or protest groups (Figure 3.7).

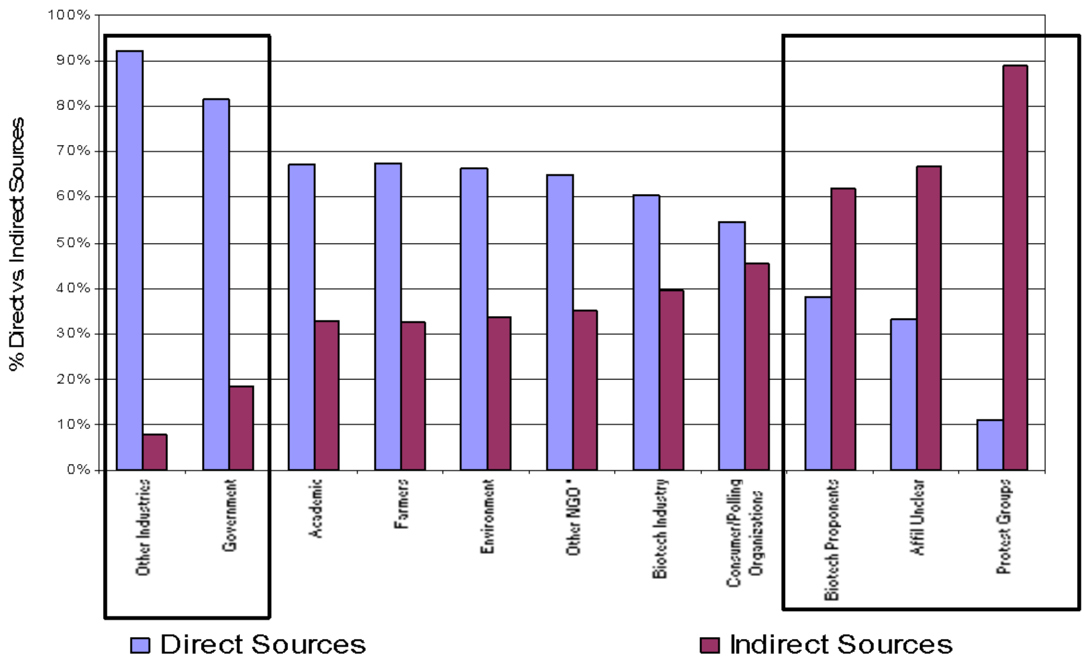
In contrast, the most directly cited groups were affiliated industries impacted by the debate over GEO safety (but *not* the biotech industry itself) and government sources—both categories that might be perceived as less polarized in the debate. Thus, journalistic practice appeared to de-legitimize "biased" sources with indirect attributions; and legitimize more "neutral" sources with direct attribution.

Figure 3.6 Indirect Use of Sources in *NYT* and *WP* Coverage



Note: A total of 316 sources were coded as indirect sources throughout the case study.

Figure 3.7 Comparison of Direct and Indirect Use of Sources in *NYT* and *WP* Coverage



* This particular comparison is not very informative because the kinds of groups represented as "other" are very distinct groups. "Other NGO" for direct sources included press club officials, financial sector analysts, and independent regulatory/food policy consultants. As indirect sources, "Other NGO" included mass media and religious groups.

Protest Groups/Opponents. Generic references to protest groups and GE "opponents" were not easily explained by journalistic convention, however. In the case study coverage, 44 references to "opponents" of genetic engineering (also variously referred to as critics, detractors, naysayers, and antis) were made in the newspaper coverage, and 20 references were made to "protest groups." Nearly all of the references made to opponents (37) and protest groups (19) never linked back to a clear reference to a specific individual or group (the first journalism convention described above). Where clear linkages could be drawn to the "opposition" references (7 instances), those cited included Jane Rissler (of the Union of Concerned Sciences), Representative Dennis Kucinich, Andrew Kimbrell (of the Center for Food Safety), Karen Oberhauser (University of Minnesota Ecology professor), Rebecca Goldberg (Environmental Defense), Charles Margulis (Greenpeace) and Jane Alexander ("an activist"). Only one of the 20 references to "protesters" could be linked *directly* back to a specific individual, Andrew Wood of Genetic Snowball. In one story covering a large, March 2000 demonstration against GE foods, there were seven mentions of protest groups, but only two named specifically in the story (one in a photo caption; one in the text of the story). Neither individual was cited with her credentials or group affiliation, and no specific reference to the person's particular concern with GE was made (*NYT* 3/27/00).

Source Prominence

Source prominence was measured to account for the multiple factors that influence how much visibility each source and *type* of source had throughout the case study coverage. Numerical systems for determining prominence *within newspapers* have been employed by various media researchers (see, for example, Pollock's long-utilized prominence scoring method in Pollock et al. 2005). This research scored prominence of sources *within articles* using the same scoring premise forwarded by Pollock—awarding higher points for earlier placement within the article, as well as appearance within headlines and graphics. Points were awarded for the location within an article that each source attribution was found and then summed across the entire case study coverage:

Location	Points
Headline/Byline	6
Graphic	5
Lead	4

Location	Points
Top Third	3
Middle Third	2
Last Third	1

For example, the most prominent source across the entire case study was the National Academy of Sciences, with a total score of 134 points, where P is prominence; H is number of appearances in a headline, subhead or byline; G is number of appearances in a graphic; L is number of appearances in a lead; T is number of appearances in the top third of an article; M is number of appearances in the middle third of an article; and F is number of appearances in the last third of an article:

$$P = (H*6) + (G*5) + (L*4) + (T*3) + (M*2) + (F*1)$$
$$P(NAS) = (2*6) + (0*5) + (3*4) + (18*3) + (12*2) + (16*1)$$
$$P(NAS) = 134$$

Table 3.15 lists the ten most prominent sources in the case study coverage. Notably, the most prominent sources were academic, government, and biotech industry sources. While Greenpeace (Environmental), farmers, and grocers also made the top-ten list, their scores were only half or less of those of the leading sources—the NAS and USDA. Of Greenpeace's 17 references throughout the case study coverage, more than half were in the last third of the article, and only once was the group awarded points for appearing in the headline, subhead, or byline of a story (the group's biotech campaign spokesperson, Charles Margulis, authored a 155-word editorial, *NYT*, 9/11/01). By contrast, of the biotech companies 35 total references, more than 70 percent were located in the top two thirds of the articles, with five points awarded for appearance in a graphic. For the NAS and USDA's part, more than half of their references appeared in the upper two thirds of the articles, and the panel and agency were also awarded higher prominence points for references in headlines, graphics and lead paragraphs (five references for the NAS and four for the USDA).

Table 3.15 Ten Most Prominent Sources Used in *NYT* and *WP* Coverage

Source	Type of Source	Prominence Score
National Academy Science	DS-Academic	134
U.S. Department of Agriculture	DS-Government	116
Biotechnology Companies	DS-Biotech Industry	90
U.S. Environmental Protection Agency	DS-Government	77
Biotechnology Industry Organization	DS-Biotech Industry	70
Losey et al	DS-Academic	64
Farmers	DS-Farmers	59
Greenpeace	DS-Environment	52
Food Grocery Companies	DS-Other Industries	48
US Elected Officials	DS-Government	40

Note: "DS-" is an abbreviation for direct source.

In aggregate, the most prominent source *types* throughout the case study were directly referenced academic and government sources (Table 3.16). Looking beyond the specific (direct) source and grouping together direct and indirect biotechnology and environmental sources, biotechnology sources where about 13 percent more prominent than environmental sources (326 vs. 284 points, respectively). However, if the prominence score of the non-descript, indirect references to "biotechnology opponents" were lumped together with the "environmental" source category (which was largely portrayed as opposed to the biotech crops), the “opposition” sources were awarded about 26 percent more prominence points than the biotechnology sources (430 vs. 326, respectively).

Table 3.16 Ten Most Prominent *Types* of Sources Used in *NYT* and *WP* Coverage

Source	Type of Source	Prominence Score
Academic	DS-Academic	456
Government	DS-Government	324
Biotech Industry	DS-Biotech Industry	196
Generic Researchers Scientists	IA-Generic Researchers Scientists	191
Environment	DS-Environment	171
Opponents-nondescript	IA-Opponents-vague	146
Biotech Industry	IA-Biotech Industry	130
Environment	IA-Environment	113
DS-Other Industries	DS-Other Industries	93
Government	IA-Government	87

Note: "DS-" is an abbreviation for direct source; "IA-" is an abbreviation for indirect source.

By either metric, numbers of references or the prominence of references, academic and government sources were the most cited sources of information for the case study articles. The journalists apparently also tried to balance the coverage of pro-biotechnology and industry sources with that of the environmental groups. While the biotechnology sources were generally given a higher prominence scores than environmental groups (Table 3.16), the environmental groups enjoyed a higher percentage of direct sourcing than biotech groups (Figure 3.7). Protest groups (IA-Opponents-vague) were covered with some prominence, but not generally legitimized with direct sourcing (they earned prominence mostly through indirect attributions).

(De-) Constructing Cognitive and Cultural Frames

Looking back through the nodes described above, some strong elements emerge that, when combined and viewed within a broader context, elucidate the construction of cognitive and cultural frames (Chapter Four). Deconstruction of media articles into the above categories of nodes (Descriptors, Definitions, Images and Sources) helped clarify leading metaphors, images and lines of discourse within the media articles. The nodes themselves, however, were not frames, per se. Rather, they are the discursive elements that constructed the immediate cognitive and deeper cultural frames.

A Public Relations Problem of Potentially Massive Proportion. Perhaps the strongest notion that emerged through the media analysis was that the biotechnology industry had a massive public relations problem on its hands as a result of the Bt-monarch case. This notion was constructed through many framing elements in the story, including

- persistent references to and descriptions of public sentiments (especially references to the general wariness of the public) and frequent descriptions of how "apathetic" or "uninformed" the American public was in terms of crop GE;
- prominence of protests, protest imagery and the battle metaphors in describing the GE debate (in particular, references to the battle for public opinion);

- journalistic practices of "balancing" treatment of GE food protests with descriptions of the potential benefits of biotechnology (GE crops were most frequently defined by their potential benefits, rather than physical characteristics or differences from traditional crops); and
- continual references to the domestic and global market impacts—of GE crops and the trade imbalances that might emerge if GE crops were rejected in the United States or abroad.

The stage was set for this interpretation of the problem early on in the Bt-monarch story, when the *NYT* covered the industry's scenario-building exercise (*NYT* 6/24/99), which reported the industry's strategic planning for the market consequences of a backlash against GE crops. The success or failure of Bt crops in the global agricultural marketplace depended on public acceptance of the food products of GE technology, as well as acceptance of the potential ecological risks from GE crops. The media accounts portrayed the emergence of a new ecological risk (and, importantly, one that was "not predicted") as the potential tipping point for a technology already beleaguered by public debate over potential food safety/security risks.

This "public relations disaster" aspect of the story was set in a truly global context within the media articles, with frequent references in particular to the negative European reaction to GE foods, global GE crop protests (and GE field destruction), and the WTO attempts to intervene on behalf of the GE crop industry and more-or-less force other countries to accept American-made GE foods or products made with GE ingredients. The global aspect of this public relations disaster also included hundreds-of-millions of human victims, according to the media storyline, the developing world's poor and under-nourished.

The Regulatory Crisis in America. Another prominent thread through the media nodes was the notion that perhaps the U.S. regulatory system was not as robust as the American public would like to have believed it was. This notion was constructed through framing elements that included

- discussion of the Bt-monarch issue in terms of a regulatory "failure" (the risks to species like the monarch weren't properly evaluated *before* Bt corn was widely planted throughout the United States);
- prominent definition of "the problem" as one with the U.S regulatory system (e.g., references to inadequacy, the "revolving door" between industry and U.S. regulatory agencies and general questioning of the notion of substantial equivalence in light of the Bt-monarch issue); and
- journalistic practice that frequently employed official government sources to defend the regulatory system, and balanced those defenses with academic researchers or "opposition" groups who questioned the adequacy of that system's pre-commercialization ecological risk assessment.

The regulatory crisis portrayed in the media had two main aspects. The first to emerge in the storyline was the concern that the regulatory system was not robust enough to catch ecological risks, especially to non-target species. This aspect emerged most directly in the very first article of the study, when UCS scientist Margaret Mellon asked the question, "Why is it that this study was not done before the approval of Bt corn?" (*NYT* 5/20/99). The questioning of the U.S. regulatory system was then sustained through the coverage with 1) the revelation that Dr. Michael Phillips was leaving the NAS panel charged with evaluating ecological risks from pesticide-producing plants for a high-profile position with BIO; 2) the Iowa State University research indicating some field validity for the Cornell research; 3) Wolfenbarger & Phifer's study critiquing the U.S. pre-commercialization ecological research for GE crops; 4) Quist & Chapela's research validating the concern over the transfer of engineered genes to crops in their places of origin; and finally 5) the revelation that Starlink had made it into the U.S. food supply, despite a regulatory system ostensibly designed to prevent such an event from occurring.

The other interpretation of the "regulatory crisis" notion was that the Bt-monarch case might lead to more regulation for GE crops, which some were eager to avoid. The industry in particular viewed overreaction to the Bt-monarch case as potentially dangerous, as it might have lead to an increased scrutiny of GE crops and the slowing of GE development and progress to market for such products. This aspect of the regulatory crisis was called to the fore in media coverage most frequently by references to the global scale and deployment of GE crops, as well as overt and implicit references to weighing the costs/risks to the monarch (or, environment in general) against the potential benefits to humankind. The implicit message here was that the American regulatory system had to balance efficiency in bringing GE products to market with completeness of pre-commercialization ecological risk assessment. There would be a potential crisis—for farmers and the U.S. crop biotechnology industry—if U.S. and global regulations were to become too cumbersome as a result of new ecological risk assessment requirements for non-target species.

Complicating the Cost-Benefit Equation with Ecology. Thus, in terms of its place within the broader social construction of the societal risks associated with GE crops, ecological risk was broadly contextualized within the global economy and the overall betterment of the human species. While monarch butterflies were on one hand a symbol of the fragility of nature and a potential victim of this new world order (ala globalization), they (and the ecological risks they became the symbol of) were also positioned within a broader cost-benefit equation that placed on the "benefits" side of the equation the potential end to both world hunger and the chemical poisoning of natural resources (land, water and other species) from agricultural pesticides and herbicides.

The predominant metaphor throughout the media reportage was of "mad science"—either through the Frankenfood trope, imagery of mad scientists/dangerous science, or protesters in protective attire and face masks in GE fields. Those "mad science" images were juxtaposed against images of monarch butterflies and larvae in a sort-of mad science vs. the gentle butterfly montage over time. There were also references to other ecological and food-safety tragedies sprinkled throughout the coverage—ala Three Mile Island and Mad Cow disease—that heightened the sense of GE crops being a venture into the unknown and the unpredictable. The takeaway message was one of uncertainties—of the future for GE crops, of the fate of the monarch butterfly, of the strength of the regulatory system in the United States, and ultimately of the stability and security of global agriculture. Claims of generic safety and substantial equivalence were more-or-less dismissed in the broader context of scientific uncertainty and the recognition of ecological complexity that emerged through the Bt-monarch media coverage. Thus, while the Bt-monarch case was ultimately "reconciled" through a single-species risk equation, it served as a segue into a more robust public discussion of ecological complexity and a more critical vetting of the notion that humankind could safely use GE crops as a key part of "sustainable" agriculture into the future.

Several cognitive and cultural frames emerged from this de-construction of media coverage of the Bt-monarch case into predominant nodes of discourse. This research goes on to explicate three cognitive frames, and two overarching cultural frames, that emerged with the re-construction of these discursive elements into meaningful organizing principles and patterns in Chapter Four.

CHAPTER FOUR

A Contextual Look at Media Framing: Cognitive & Cultural Frames

Chapter Contents

In reality, science is not pure; context counts. This recognition is critical to good science and is the most useful of the 'postmodern' insights—the relationship between power and knowledge.

(Song & M'Gonigle 2001)

Science is often a site of struggle over ideas and power, a discourse in which political and social battles are fought.

(Proffitt 2004)

Introduction

Several studies of the crop biotechnology controversy, its media coverage, and correspondent public perceptions have emerged in recent years Matthew Nisbet and colleagues from The Ohio University and Cornell University have conducted trend analyses of media frames in U.S. newspapers comparable to those found in European media research on the issue (Nisbet & Huge 2006; Nisbet & Lewenstein 2002; Gaskell & Bauer 2001). These studies, which support McInerney, Bird & Nucci's (2004) finding that the Bt-monarch and Starlink events were central catalyzing stories for media coverage of ecological risks, have focused on exploring Downs' (1972) issue attention cycle, and used multi-coder content analysis techniques to identify organizing frames in articles about agricultural biotechnology. Vilceanu & Murphy (2005) used a content-analysis-based network analysis to discern differences in the "frames" utilized by French and U.S. newspapers during the timeframe of the present Bt-monarch case study. Andree (2002) employed a Foucauldian geneology to explicate how the frames of substantial equivalence and precaution were constructed over the course of the late-Twentieth Century and how these "biopolitical" (and then, "ecopolitical") frames influenced Canadian GE policy over time.

These studies focus on broad conceptualizations of genetic engineering and public opinion on issues of GE impacts to human health, economics, and the environment. McInerney, Bird & Nucci (2004), for example, studied how news releases about the Bt-monarch "event" influenced the writing of news stories about GE food in the popular press. The study traced the media coverage of GE foods from 1992 until 2002 and discussed how the volume of media coverage increased as a result of the Bt-monarch and Starlink media events. In the coverage of the Bt-monarch case, the authors emphasized how the *Nature* news release and subsequent media coverage about the Losey, Rayor & Carter (1999) research "left out" the important fact that the research was preliminary, and subsequently "may have set an agenda of worry among the reading public" and "also brought fear of stigmatization to the biotechnology industry" (p. 69). The authors further argued that the media coverage likely started a "ripple effect" in the media over GE foods, which they argued would set the stage for continued discussion of ecological and food safety risks (ala Kasperson 1992).

Gaskell & Bauer (2001) examined the position of the biotechnology "movement" in the "public sphere"—a position defined by the intersection of regulation politics, public perception and mass mediation. This multi-faceted research approach engaged several dozen researchers around the globe, and included surveys and focus groups to discern public opinion across 16 countries; content analyses of “elite” media salience and frames; and a review of how regulatory policies were shifted as a result of key trigger events. The work represents a cross-cultural examination and comparison of how “red” (i.e., medically oriented) and “green” (i.e., crop-oriented) biotechnologies were publicly negotiated during two “waves” of development: the first, 1973-1996; the second, 1996-2000.

I build on these previous research efforts in order to better understand how the print media framed the ecological risks from Bt corn pollen to monarch butterfly larvae amongst the broader cognitive and cultural frames at play in the media coverage of GE crops as a whole. Media coverage of the Bt-monarch case was occurring in a broader context of American trade disputes and amidst evolving cultural understandings and presumptions about the role of the United States in a global world. This context called out related socio-economic, philosophical and political risks—and their frames—so that media audiences might more broadly comprehend the place of ecological risk in the GE debate, which at least one Royal Society of Canada panel recognized were, “part of the larger public debate over genetic engineering that the government should not lose sight of in an effort to define a purely technical solution to the genetic engineering controversy” (Andree 2002, p. 185).

The immediate cognitive frames—and the broader cultural frames through which this case study took place—ultimately influenced how ecological risks were socially negotiated in the mass media. Thus, one cannot simply look at the component symbols, rhetorics and structural article elements of ecological risk, the precautionary principle, or scientific research and reasonably expect to attain a robust understanding of the framing of ecological risk in the Bt-monarch case. One must also look at the corresponding cognitive and cultural frames that influence the framing of ecological risk to meaningfully understand the dynamics of how ecological risk was socially constructed through media and stakeholder frames. In other words, frames do not occur in a vacuum, but are constructed through the interplay of core cultural and supporting cognitive packages that are socially negotiated in a variety of public forms of discourse (Hertog & McLeod 2001; Bauer 2005; Reese, Gandy & Grant 2001).

Methods

The research in this chapter builds on the findings of the previous chapter's analysis of descriptors, labels, definitions, images and sources, fleshing out the cognitive and cultural frames at play in the construction of ecological risks from Bt corn pollen to monarch butterfly larvae. Two influential cultural frames, built from three situational cognitive frames, are proposed and evaluated here following a detailed analysis of media symbols and rhetorics uncovered in the previous chapter's research. The chapter also explores two "reverse discourses" (or, "counter-frames") that were largely under-represented in U.S. newspaper coverage: systems sciences and the precautionary principle. These reverse discourses were, however, present in various supporting stakeholder documents that were analyzed as part of this research. As the cognitive and cultural frames were deconstructed through the research process, a descriptive model for the interplay of cognitive and cultural frames emerged, and is further described in the concluding pages of the chapter (p. 276). Here it is necessary to outline the basic form of this descriptive model, however, before the cognitive and cultural frames are examined.

Research Progression

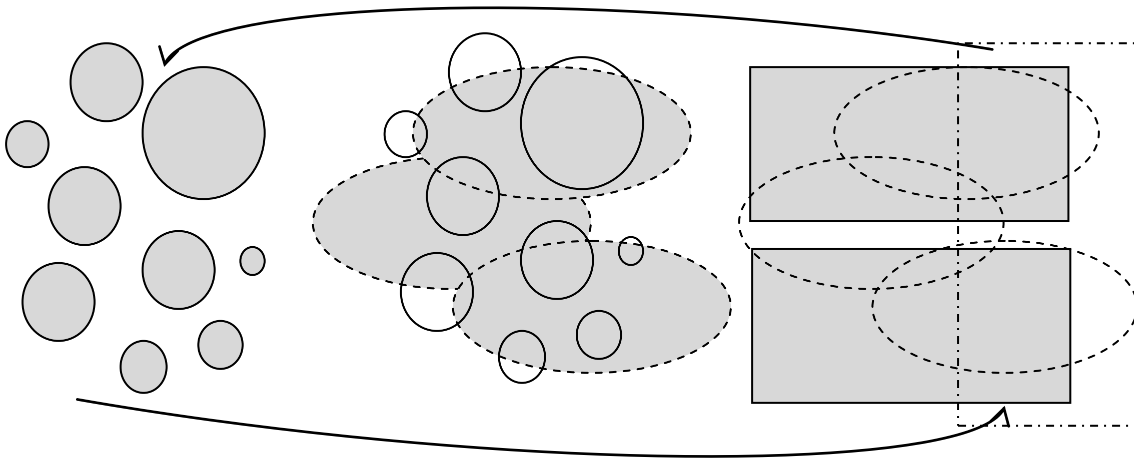
The chapter begins with an examination of three cognitive (situational) frames that dominated the newspaper coverage throughout the case study timeframe. Discussion of ecological risks from Bt on monarch larvae were imbedded in broad cognitive frames that provided the news "hook" for journalists to carry the coverage forward on the media agenda: ***1) The Butterfly Effect***; ***2) Super Science—Super Problems***; and ***3) Crisis of Confidence.*** These frames were first deconstructed and explicated through careful examination of media discursive elements and supporting documents. The cognitive frames were closely linked, and developed into the predominant storyline of the time:

> The negative public opinion of GE crops in Europe will be bolstered by new evidence of potential ecological risks (from the monarch butterfly research). That negative opinion could spread to U.S. consumers and sideline a potentially helpful, and profitable, agricultural innovation (GE crops).

Following the deconstruction of the cognitive frames, I proposed predominant cultural frames, and then explored how these frames were constructed and revealed through the discursive elements and cognitive frames utilized in the Bt-monarch newspaper coverage. The predominant cultural frames that emerged during this process were ***1) Science as Savior*** and ***2) The Free Market Rules***. I also explored the two "reverse discourses" that challenged these leading cultural frames, but were under-reported in the U.S. newspaper coverage of the Bt-monarch case.

I began with the deconstruction of the cognitive frames related to ecological risk in the Bt-monarch case study, which I then refined through further examination of supporting document sources (Appendix C) and verified through examination of a set of alternative cultural document sources (see discussion of research triangulation below). The original cognitive frames hypothesized were proposed and then revised and explicated from evidence uncovered in the previous chapter's research—based both on *predominance* of rhetorical and symbolic media conventions examined previously (NVivo nodes), as well as on the *relevance and relationship* to the subject matter—ecological risk. Appendix C details the nodes examined in the construction of the cultural and cognitive frames. From this revised examination of cognitive frames developed in the media coverage of the Bt-monarch case study, the first cultural frame was proposed and evaluated for its inclusiveness of the cognitive frames and discursive devices and symbols from which it was constituted, as well as for its comprehensiveness in describing a broader cultural tenet expressed within the case study media articles and supporting document sources. See Figure 4.1 for a schematic representation of the research method's progression.

Figure 4.1 (De-) Construction of Cognitive and Cultural Frames



Note: The research began with the identification of nodes (of various scope and prominence) within the case study media documents (Chapter Three). Cognitive frames (immediate, case-specific) were then proposed and (de-)constructed through re-examination of nodes, case study media documents and supporting research triangulation documents. Finally, cultural frames emerged, were examined, and refined through an iterative process as other cognitive frames were developed and analyzed in case study media documents and supporting research triangulation documents. Here ovals represent cognitive frames; rectangles represent cultural frames; arrows represent both the iterative research process, as well as the interaction of cognitive and cultural frames with one another in the mediated construction of risk. Reverse discourses (or, "counter frames") also emerged through the examination of supporting triangulation documents; those discourses are represented by the dashed rectangle here.

Following the deconstruction of cognitive frames, I explored how the cognitive frames supported and contributed to an overarching cultural frame on technological progress (cultural frame #1, above), and then to cognitive and cultural frames addressing the U.S. role in a global economy (cultural frame #2). The research also examined reverse discourses (sometimes referred to as "counter frames" in the literature) that represented alternative worldviews and thus challenged these predominant cultural frames, the system science and precautionary principle discourses. These reverse discourses emerged largely as a result of my research triangulation strategy.

The way the Bt-monarch case was framed in the media may provide insight into how ecological risks from GE crops will be socially constructed into the future. This is true not only because of the volume of newspaper coverage from this very public controversy and the symbology the monarch evoked (as McInerny, Bird & Nucci 2004 and Nisbet & Huge 2006 argue), but also because any future ecological risk event from agricultural biotechnology will likely also evoke similar cultural frames related to notions of U.S. leadership in the global economy—in terms of technological progress, global humanitarianism, and free-market capitalism. These notions are, of course, in direct competition with an alternative, more protective perspective of the human species' responsibility to and place within the global commons (precaution and a systems worldview).

Triangulation

In order to validate the research findings, additional data sources were used to triangulate findings throughout the course of the research process (n = 162, Appendix B). Where frame sponsorship assertions are uncovered and explicated, I examined the sponsoring organization's Web site and other supporting documents to confirm and further explore the frames. I located Web site content from the time of the case study using the organizations' own Web archives or the Wayback Machine Web Archive, a 501(c)(3) non-profit that was founded to build an Internet library offering permanent access for researchers to historical, digital-format collections. In addition, I examined several other academic papers, written at the time the case study was unfolding, to challenge or confirm these research findings.

Building on a tradition in navigation and military operations that uses multiple reference points to accurately locate a subject's position, research "triangulation" increases the accuracy of research judgments by using a combination of methodologies and perspectives to study a subject (Jick 1979). Good triangulation will test findings both internally and externally; "within-method" triangulation checks for internal consistency by using different techniques to collect and interpret data within the same research method, while "between-method" triangulation tests the degree to which different methods yield similar results.

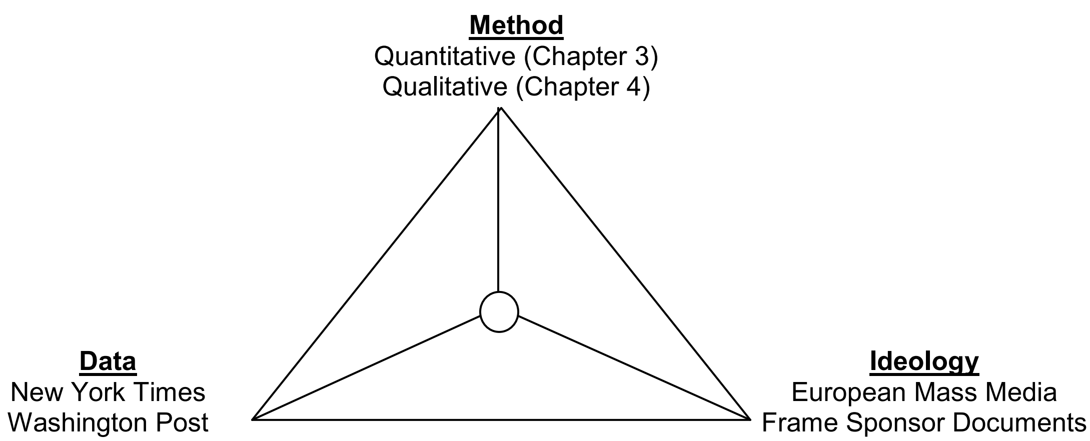
The present research was designed to triangulate in three ways (as suggested in Hertog & McLeod 2001):

1) a "between-method" triangulation, using a combination of quantitative and qualitative research methodologies to analyze media accounts of the Bt-monarch case study (Chapter Three is largely quantitative; Chapter Four, largely qualitative);

2) a "within-method" triangulation to test consistency between opinion-leading media sources, using comparable, but dissimilar, document sources for the media and frame sponsorship analysis (two different opinion-leading U.S. newspapers, *New York Times* and *Washington Post*); and

3) an "ideological" triangulation (suggested by Hertog & McLeod 2001) to stretch the researcher's ideological boundaries by reviewing publications from ideologically dissimilar points of view: U.K. newspaper sources across the same time period and dissimilar (pro- vs. anti-GE) document sources (Appendix B).

Figure 4.2 Case Study Research Triangulation



As Jick (1979) and Hertog & McLeod (2001) point out, multi-method and multi-perspective research is useful whether there is convergence or not, because even where *divergence* is found, “alternative, and likely more complex, explanations are generated” (Jick 1979, p. 608). Of course, where *convergence* is located, the researcher has considerably greater confidence in his/her research conclusions, with the caveat that the determination of validity is, in itself, likely to be subjective due to the lack of systematic guidelines for evaluating “eclectic” data and the differing nature of multi-method results. Thus, in the final analysis triangulation still leaves the researcher searching for logical patterns, “piecing together many pieces of a complex puzzle into a coherent whole,” (Jick 1979, p. 608).

Frame Sponsorship

Stakeholders engaged in public discourse about controversial issues usually seek to present information in ways that support their particular worldview. Frame sponsorship can be both active and passive, and include issue sponsorship (influencing *what* issues are on the media agenda) and attribute sponsorship (influencing *how* issues are discussed in the media). The content analysis software used for this research, QSR NVivo (Version 2.0.163), enabled analysis of where the “Information Source” node groupings (direct sources and indirect attributions) coded similar passages with the “Definitions & Discursive Elements” (Descriptors & Labels; Problem or Solution Definitions; and Biotech or Bt Definitions) and “Risks & Safety” (Ecological Risk; Food & Health Safety Risk; and Role of Science in Risk Regulation) node groupings. These linkages provided promising threads to cognitive frame sponsorships within the media discourse, which were explored further through examination of supporting document sources.

The discussions of frame sponsorship that follow should not be read or interpreted as a causal relationship. How media practitioners gather, translate, and finally come to represent and frame information is a complex and interactive process, and such analysis is clearly beyond the scope of this research. Some of the factors that influence frame sponsorship and reporting include access to journalists; social position and networks; the perceived trustworthiness and credibility of sources; institutional structures (impacting both the media and the sources); and pressure on science writers to conform to certain scientific values (Anderson 2002, Petersen 2001). What the reporting of frame sponsorship in the present research effort accomplishes is to highlight the ways that media representations are "the outcome of a competition among a number of news sources, each seeking to provide their own definition of the public representation of an issue" (Tammpuu 2001, p. 197-198).

Cognitive Frames

According to Proffitt (2004), debates over conservation issues require conservation professionals to engage in dialog and negotiation with social "actors" who are outside of the conservation biology field. In an effort to communicate with one another, those dialogs must occur through establishing a shared system of meaning and understanding. In the Bt-monarch case, the terms of discourse for non-scientific actors were largely negotiated and constructed through the mass media. The emergence of several situational, cognitive frames can be traced through analysis of the terms of discourse (definitions, descriptors), images and sources used in the preceding chapter's research findings. These frames, and the cultural frames they evoke, served to direct the course of debate over the ecological risks from Bt corn and other agricultural GEOs. According to Proffitt,

> Meaning systems and interaction produce dominant cognitive, normative, and regulative structures that guide debate and decision. In short, institutional fields operate around dominant interests, habits, and beliefs that constitute legitimate actors, problems, and solutions. (p. 58)

The newspaper coverage of the Bt-monarch case, and the associated public debate about risk from GE crops in general, legitimized certain points of view over others and promoted certain constructions of the "problems" and "solutions" being debated over others. One central cognitive frame, "The Butterfly Effect," reduces to emotionality most of the concern for monarchs and the "fragility of nature" that the butterflies represent. Another, "Super Science—Super Problems," promotes biotechnology as the only way to feed a growing world population, but one that is not without serious problems. The most pervasive media frame employed to negotiate and explain these frames was the "Crisis of Confidence" cognitive frame, which appears in newspaper coverage of the Bt-monarch case throughout the entire timeframe of the case study and captures the obvious tension that exists between the two other dominant frames within the media story.

The Butterfly Effect

"The Butterfly Effect" frame was initiated very early on in the case study coverage, in the second article written that mentions the Bt-monarch case. The *New York Times* business section reported on a scenario-building workshop that several biotechnology companies hosted to think through various scenarios as "an early warning system for how their strategies could go astray" (*NYT* 6/24/99). One of the three scenarios that the group constructed as part of the workshop was clearly intended to help the industry manage the public "controversy" that was emerging over the potentially lethal impact of Bt corn on the monarch butterfly:

> A second scenario is likely to reflect chaos theory, which holds that complex systems can be changed radically by tiny disruptions that have dramatic ripple effects. This story might turn on an event such as publication of a small research report attributing an environmental setback to genetically engineered crops. This in turn could kick off a string of public reactions leading to drastic regulations that stifle many biotechnology applications. A Presidential candidate who is courting environmentalists could be cast as the leader of the anti-biotech charge (*NYT* 6/24/99).

The reference is recalled again later in the year in *New York Times* magazine piece that was written in the end-of-the-millennium, news-recap genre:

> In recent months, activists dressed as monarch butterflies have popped up in London, Chicago and Washington (as well as Seattle), reminders of a famous recent study at Cornell that found biotech corn may pose a threat to the beloved insect. A cliché of chaos theory holds that the flutter of a butterfly's wing in, say, Timbuktu, can set off a hurricane half a world away. So it was with these butterflies in Ithaca, who moved the biotech story from the business pages to the front pages. For most Americans, it came as news that there were already some 20 million acres of biotech corn planted in the United States. You mean we're already eating this stuff? (*NYT* 12/12/99)

The flutter of butterfly wings/chaos theory metaphor is, of course, apropos for the Bt-monarch case. The original metaphor was popularized in the 1960s by chaos theorist Edward Lorenz, who coined the term the "butterfly effect." The metaphor suggests that the flutter of a butterfly's wings in one part of the world could cause a hurricane in another far-away part of the globe. The "tiny disruption" unleashing a "hurricane" in the Bt-monarch case can be interpreted in one of three ways.

1) The environmental view that the insertion of a small amount of genetic material could have devastating ecological consequences.

   For example:
   "Genetically engineered organisms released into the environment pose risks that are potentially irreversible, untraceable and uncontrollable," said Charles Margulis, a spokesman for the environmental group Greenpeace. (*NYT* 11/19/99)

2) The pro-biotechnology viewpoint that the toxicity of the Bt toxin to the monarch is a small price to pay for potentially ending world hunger, which in the industry view will be impossible if GE crops were prohibited from further development.

   For example:
   But damage to the Monarch has to be weighed against the prospect that fewer forests will be cleared and fewer children will go hungry. (*WP* 7/9/01)

3) The industry concern that the initial Bt-monarch finding could further erode the European Union's confidence in biotechnology, and that fear could "spread" to the United States and other parts of the world.

> For example:
> The beating of a butterfly's wings in one hemisphere, it turns out, really can cause a hurricane in the other.
>
> Last month, researchers at Cornell published findings that genetically altered corn, designed to produce pollen toxic to pests, could also kill caterpillars of the monarch butterflies, whose principal breeding range is the American corn belt. Americans heard this news with a momentary shrug of disapproval. But in the European Union, environmental officials are taking the news much more seriously.
>
> Under pressure from consumers fed up with what British newspapers call "Frankenstein food," the union was tightening regulations…Now the butterfly-killing corn seems likely to be barred under a tacit moratorium on permitting any new items until the Europeans can agree on new rules. (*NYT* 6/27/99)

Frame Construction. While all of these interpretations of the metaphor appear at some point in the media coverage, it is this third representation that is the most persistent cognitive frame through the first year of the Bt-monarch case study newspaper coverage. The Butterfly Effect frame appears in both newspapers, but the emphasis appears greater in the *New York Times*, since that paper accounts for a substantially higher percentage of the media coverage of the Bt-monarch case during the timeframe this frame is constructed. The frame emphasizes the fragility of nature, the perceived emotionality of "anti-biotech" arguments, the de-legitimization of protest and opposition groups, and ultimately the need to control the "chaos" that stems from such "irrational" arguments against biotechnology. The consequence of the last emphasis is described in the "Crisis of Confidence" construction that emerges from the battle/conflict rhetorics (p. 210). The media and key interest groups employ various discursive elements and symbols to promote their interpretation of the metaphor.

Fragility of Nature. The emphasis on the fragility of nature is most readily evoked with photos of the monarch butterfly, which appear prominently throughout the newspaper coverage from the story's inception until September 2000. Nature's fragility is well captured by the image of a butterfly, whose paper-thin wings and naturally fluttering mode of transport easily evoke frailty and even feebleness if its flight path is upended by a steady wind. The images of this brightly colored butterfly, in particular, perched on flowers or hanging from foliage also creates a sense that the insect is a "sitting target" for predation or some other type of stochastic event. Because this fragility theme is best characterized by the butterfly form of the monarch life cycle, it's not surprising that media and environmental group images emphasize the butterfly life phase, rather than the one that is the actual subject of Bt toxicity—the caterpillar.

Environmental and protest groups employed the monarch butterfly image throughout this period to emphasize nature's fragility, using the image in their reports, Web sites and brochures (the logo of the U.S. Union of Concerned Scientists features the monarch image, perched on a globe, and Greenpeace featured several images of the butterfly on its U.S. Web site). These groups also used the monarch as symbol of fragile ecology in street-theater demonstrations, which the *New York Times* reported in a November 1999 article about the protest outside an FDA hearing in Chicago:

> At one point, a group of girls aged 2 to 7, dressed as monarch butterflies, danced near a man portraying a large stalk of corn bioengineered that released genetically engineered pesticides. All the children fell down, playing dead, on cue. (*NYT* 11/19/99)

While the fragility of nature was employed tacitly, yet persistently, throughout newspaper coverage with the monarch imagery there was also one very explicit reference to the "fragility of nature" aspect of this frame in the *New York Times* in September 2000 (emphasis added):

> The report comes after more than a year of controversy following the publication of a Cornell University study showing that Bt-containing pollen from the genetically modified corn could kill monarch butterfly caterpillars in the laboratory. That finding turned the monarch into a *symbol of fragile nature* threatened by biotechnology. (*NYT* 9/26/00)

The reference was quite prominent in the story, appearing directly under the headline, "Biotech corn isn't serious threat to monarch, draft U.S. report finds." In an apparent attempt to temper, or even challenge, this headline, the article was formatted to include a prominent pull-quote beneath the headline that reads, "Finding a balance between hardy crops and fragile species," and a caption beneath a photo of a monarch perched on a delicate-looking flower, wings outspread, that reads "The monarch butterfly, often used as a symbol of the fragile ecology."

Greenpeace news releases and European newspapers noted that the monarch was considered a "flagship" or "touchstone" species for conservation ("Monsanto & Novartis GE maize harms butterflies" 5/20/99; *Independent London* 5/20/99; *The Times London* 12/14/00). One European newspaper even called the monarch the

"Bambi of the insect world" (*The Times London* 1/17/00). The Union of Concerned Scientists' (UCS) Web site was upfront about its connection of the butterfly with the notion of nature's fragility, describing monarchs as, "widely admired for their long--up to 3,000-mile--migration and their spectacular habit of overwintering massed together in trees in a few isolated spots in Mexico…" and noting that, "Because of their large size and splashy coloration, they are often used as symbols of nature and biodiversity," ("Toxic Pollen Threatens Monarchs," May 1999). In other pages on its site, the UCS asserted that monarchs were known, "to practically every school child in the United States," and were "prized not only for their beauty and size but also for the wonder of their long autumn migration…and are also valuable as pollinators of many flowers," ("Monarch Butterflies and Toxic Pollen," Oct 2000).

While the butterfly is a readily accessible cultural symbol of the fragility of nature in the face of human impacts, the monarch is perhaps actually not the best poster child for the fragility theme, given the species' unequaled, long-distance migration to Mexico each year—a feat that requires incredible endurance and resilience. Nevertheless, the symbol was readily employed throughout the first year and half of the case study. Unfortunately, the metaphor's emphasis also helped proponents of biotechnology assert that concerns over ecological risks were largely emotive in their nature, which ended up being the second aspect of the chaos frame—the assertion that emotional arguments would spread and cause a market chaos that could thwart progress of GE crop applications.

Emotional Europeans with Irrational Fears. At some level, the American public's "fondness" for the "beloved" butterfly (*NYT* 12/12/99, 1/17/00) could be dismissed as an overly romantic—even privileged—concern within a broader capitalist marketplace where genetic engineering could be used to earn U.S. farmers millions of dollars and save the lives of countless millions globally (as suggested in the #2 interpretation of the chaos metaphor above). This kind of perceived emotionality toward the monarch is, of course, in stark contrast to the rational, science-based thinking of agricultural regulators and molecular biologists. Such rationality was conveyed in one instance by a USDA official acknowledging that the agency had long known that monarchs and other butterflies would be susceptible to Bt corn, but called the impacts to these non-targets "part of the general background noise" (*NYT* 12/19/00).

The essential news "hook" for the emotionality argument came from overseas, where trade tensions between the European Union and the United States were escalating due to the EU's reluctance to accept GE crops from the U.S. food producers and feed suppliers. The biotech industry and U.S. governmental regulators reduced European concerns about ecological and human health risks down to purely emotional, and irrational," arguments and were quite vocal in their hope that the kind of "inanity" in the "anti-GM" arguments that existed abroad would not spread to the general public in the United States (*NYT* 3/14/00).

This aspect of the The Butterfly Effect was introduced into the media coverage only three days following the first reference to chaos theory (*NYT* 6/24/99). The article, "Fear of feeding: Europe loses its appetite for high-tech food," appeared in the "Week in Review" section of the Sunday newspaper and featured a photo of London protesters advocating for a moratorium on GE foods and wearing hazmat-type suits emblazoned with the slogan, "five year freeze." The article was devoted to outlining in very direct terms the four major reasons why the journalist (once a European foreign correspondent) believed Europeans were wary of GE foods: 1) they over overly protectionist ("Europe resents the fact that many of the patents on genetically modified crops…are held by American companies"); 2) the French have "a different attitude" about food ("they don't like 'industrial' tomatoes, fruits and vegetables because they think these products just don't taste very good"); 3) Europeans are already "panicked" about food because of the recent food scares in EU countries (e.g., the article contains lengthy discussion about the regulatory failures that led to mad cow disease and dioxin contamination in food, "Americans might be nervous too, if the Food and Drug Administration had as dismal a record as Europe's bureaucracies"); and finally 4) Europeans have a damaged psyche when it comes to genetic engineering in general:

> …there is a psychological connection; a lack of confidence that the officials who are supposed to protect Europeans from unseen dangers will do their job well, or even admit there is a threat. In such an atmosphere, distrust of anything new flourishes.
>
> And Europeans also have one more reason to be wary about genetic manipulations. Hitler had an interest in it. Nazi abuse of science has left scars in the popular psyche that make European environmentalist

> parties, especially in Germany, particularly skeptical about the wisdom of toying with genes—even in plants.

This notion of European emotionalism presents itself 32 times in the newspaper coverage in both overt and subtle ways (emphasis added): official U.S. administrative language that calls Europeans "*'irrational'* because of their opposition to genetically modified foods" (*NYT* 7/14/99); headlines that read "France's *fickle* appetite" (*NYT* 8/2/99) or "Protests on new genes and seeds grow *more passionate* in Europe" (*NYT* 3/14/00); the reporting Prime minister Blair's rant against the British media for "*fomenting hysteria*" over GE food (*NYT* 8/23/99); and even the use of the more emotive verb "fear," instead of "are concerned," when discussing European reaction to GE crops ("fear" is used nine times in reference to European reaction, as opposed to the less-emotive "concern" construction, which is used only twice). The Europeans are also reported as displaying a rising "anti-American" sentiment (13 references) and sometimes viewing the American responses to concerns about GE food as "arrogant" (three references). The concern expressed by Europeans is contrasted with the American reaction of GE foods at that time, which was typically characterized as either "apathetic" or "uniformed."

De-Legitimizing Dissent. The concern presented in the first-year newspaper coverage of the Bt-monarch case was that "fear of GE" and these "irrational" arguments against the technology would spread to the United States as a result of the Bt-monarch findings, especially following the WTO protests:

> Whether European fears will spread to America is unclear…American seed producers like Monsanto and DuPont's Pioneer Hi-Bred International are under pressure not just by environmental activists but by food makers like H.J. Heinz, Gerber and Frito-Lay who have stopped using biotech ingredients and by corn farmers who switched to the seeds and then saw consumer fears shake European markets. (*NYT* 3/14/00)

Indeed, as the media trend line of GE-related stories shows (p. 14), there was a definite upturn in the level of media coverage of GEOs around the time that the Bt-monarch case first came to light in the United States, and more U.S. consumers than ever before were demanding labels and stronger pre-market testing of GE foods (True Food Network 2003). Those Americans who chose protest as a form of public dissent over the proclaimed "safety" of GE crops and the regulatory system that approved them, often found their voice de-legitimized in the newspaper coverage, with relatively low prominence scores on textual references to their positions on the issue, indirect attributions for "protesters" who spoke to reporters, and images that emphasized the deviance aspect of protests (e.g., destruction of fields, costumes, protest signs with sound-bite slogans, and protesters captured with their mouths open, apparently shouting). The "chaos" that was being created in the United States—in the form of organized, mostly non-violent protests and civil disobedience (WTO excepted, of course)—was often treated by the "circus atmosphere" frame (emphasis added):

> Outside, in a broad plaza *ringed* by federal buildings in Chicago's downtown Loop, members of Greenpeace and several other environmental groups *paraded* with signs declaring "Genetically engineered food is poison." They also *staged skits* in which children *costumed* as Monarch butterflies fled in *mock terror* from a figure

> dressed as a huge gene-altered ear of corn and a protester portraying a biotechnology farmer injecting hormones into *a papier-mâché cow*. (*WP* 11/19/99)

The newspaper coverage also frequently sought reaction to the protests from industry and government sources (and one *WP* editorial staffer offered his assessment as well), reactions that usually indicated that the protesters and "opposition" to GEOs were either outside of the mainstream, or being selfishly elitist by ignoring the needs of the poor. Tammpuu (2004) argues that these "ordinary citizens" are often included in media accounts only to provide a "symbolic presence" of the human angle on science stories, and to legitimize scientific perspectives on science controversies. Consider the following examples to illustrate the point (emphasis added):

> "You've seen the *shrill statements* and *outrageous tactics* by people who are *attacking* biotech foods," said Gene Grabowski, a spokesman for the Grocery Manufacturers of America and the Alliance for Better Foods. "*Our [Web] site is intended to be based on fact;* it's decidedly pro-biotech, but *it's not intended to be strident*." (*NYT* 11/12/99)
>
> On the one hand, Mr. Rajavelu [a financial analyst for technology sector] said, he thought the conference participants probably saw the protest as *nothing but entertainment*. On the other hand, he said, "This is a cause that a lot of people could easily relate to, so they will most likely *get on the bandwagon*." (*NYT* 3/27/00)
>
> It's one thing for *affluent consumers* to eschew transgenic foods. It's another for the affluent to *impose their choices on poor people*. China has shown that genetically modified rice can boost yields by 15 percent in the Third World. But *Greenpeace pressures developing countries* not to follow China's lead. When Kenya faced famine last year, the antis urged the Kenyan government to refuse U.S. food aid because some of it was genetically modified. (*WP* editorial 7/9/01)

In addition to de-legitimizing organized public dissent, scientific research was also fair game for de-legitimization and marginalization, long before the scientific uncertainty surrounding the impacts of Bt corn was resolved in any meaningful way. The newspapers reported the biotech industry position that the Losey, Rayor & Carter research was "sloppy" or "flawed" (*WP* 11/3/99, *NYT* 9/9/01)—rather than "preliminary"—as well as the industry's dismissal of the Hanson & Obrycki (2000) research (emphasis added):

> "Dr. Obrycki's research *stands in the shadow of more than 20 independent studies* by widely recognized scientific experts who have found that Bacillus thuringiensis corn does not pose a significant risk to the monarch butterfly," [Giddings] said. "This report considers only one small area of this complex topic and the conclusions put forward by the authors *stand in stark contrast to those of the broader scientific communities'* research." (*WP* 8/22/00)

Ultimately, the industry embraced its version of the The Butterfly Effect frame, using its core elements of emotionalism leading to chaos and the discrediting of those who employed "emotive arguments" about butterflies. This frame enabled the industry, regulators and journalists to interpret the "problem" in the United States as a public relations misstep, rather than a problem with potentially serious ecological consequences. The media reflected that frame throughout three-quarters of the total coverage of the case. Both the industry and government regulators made broad claims of safety to butterflies, birds, animals and human health throughout the entire case study, which the newspapers also readily reported. Despite a growing body of scientific evidence suggesting that the U.S. scientific community and regulatory system had grossly underestimated the complexity of ecological interactions at play in risk assessment for Bt crops, the predominant frame that was reported was that the biotech industry and regulatory agencies had a public relations problem. This "crisis of confidence" frame is discussed in more depth below (p. 210).

Precaution: the Undertold Story. The story that got lost when the The Butterfly Effect frame was interpreted this way, however, was the very story environmentalists were trying to emphasize by employing the monarch symbol in the first place: proceed cautiously so nobody gets hurt—especially the innocent. The term "precautionary principle" is only mentioned once in the media coverage:

> For now Western Europe is the world's stronghold for this thinking. Both in government and in private activist groups, people praise "the precautionary principle," a fancy way of saying "better safe than sorry." While U.S. officials argue that there is no real evidence that the products are dangerous, Europeans say there is no real proof that they are safe and have blocked entry of new products. (*WP* 1/24/00)

The word "caution" is also used only two additional times in the coverage in reference to the notion that the United States ought to proceed cautiously with its policy of letting companies police themselves—a notion that is presented as contrary to the precautionary approach. This aspect of the media coverage is discussed further in the section on cultural frames (p. 267).

Super Science—Super Problem

Super Science. Counter to the "emotionality" of the The Butterfly Effect frame was the Super Science frame, which posits the Promethean optimism that whatever problems and risks the human species encounters, science and innovation will solve. In the Bt-monarch case, biotechnology was framed as the answer to myriad human problems: environmental destruction, human disease, malnutrition and even manufacturing constraints. To a lesser extent, the science of ecological risk assessment was framed as the optimal way to mitigate the perceived ecological risk from GE crops. The label for this frame came from the cartoon that appears in the *Washington Post* late in the case study coverage (*WP* 5/30/01), and was something of a culminating image for the treatment of the potential of biotechnology throughout the case study coverage (Figure 4.3). Extolling the promises of crop biotechnology was a permanent feature of the Bt-monarch case study coverage—beginning with very first article announcing the Losey, Rayor & Carter study, "farmers may find it difficult to lay aside Bt corn…Now they can plant Bt corn and let the internally produced toxins do all the work" (*NYT* 5/20/99), and carrying into the very last article in the case study, which announced that the EPA renewal of U.S. permits to plant Bt corn, "a useful and effective tool for farmers," (*NYT* 10/17/01).

The key components of the Super Science frame were a continual emphasis on the potential benefits that might be realized from GE crops; the notion that genetic engineering is the *only* way to achieve these benefits; and a tacit promise that, even if the products of GE end up causing some "super big problems," science and innovation will find a way to identify, evaluate and solve them. The frame was visually evoked throughout the case-study newspaper coverage with artwork emphasizing the sophistication of the technology, particularly the double-helix and “promising science” imagery sprinkled throughout the articles, and the hard-to-miss quarter-page graphic illustrating GE methods in the *NYT* “Redesigning Nature” special report (11/3/99).

The metaphor that was evoked, on both sides of the GE crop debate, was one of super-human powers. On the one hand, GE crops were proclaimed to be the ultimate advancement of science in the name of solving extraordinary problems (ala “super veggies”); on the other, they possibly had become the superhero-gone-amok that, armed with super-human strength, could become an unstoppable villain (ala “Frankenfoods” and “superweeds”). The significance of this metaphor should not be under-estimated. According to Tammpuu (2004)

> Since images are not only descriptive, but also interpretative and evaluative, the selection of particular metaphors is therefore often strategic rather than accidental. Hence, metaphors are equally used by geneticists in order to promote their work and persuade the public of its importance for health-care for example, as well as by critics to express their concern about ethical and moral implications of gene technology on the other hand. Repeatedly presented and re-occurring metaphors in turn are argued to come to affect perception and understanding of scientific issues and events. (p. 197)

Figure 4.3 "Superveggies" by Brad Hamann for the *WP*

Note: This image is reproduced here with the permission of the artist, Brad Hamann, Brad Hamann Illustration & Design, www.bradhamann.com.

Feed the World. The predominant promise of genetic engineering reported throughout the Bt-monarch case study was that genetic engineering would move humankind from the "green revolution," with all of its synthetic chemical inputs into the agricultural production chain and the environment, to the "gene revolution," which would ostensibly convert less natural land into agricultural production by increasing yields on already-cultivated land, without the need for chemical spraying of herbicides and pesticides. There were 20 references to this "feed the world" theme throughout the case study newspaper articles, beginning in the summer of 1999 and appearing throughout the coverage into the summer of 2001:

> … the American public is not up in arms about soybeans and is receptive to the idea that these high-yield genetically engineered crops hold out hope for the future of a hungry planet. (*NYT* 8/2/99)
>
> This [projected world population] increase, together with rising incomes, means that crops will have to grow by about a third…We could do that by chopping down forests…Or we could do it by boosting yields with new technology…lack of plentiful cheap food harms human health enormously…. (*WP* 7/9/01)

The developing, or "third world," hungry were portrayed as a potential major beneficiary of (or, victim to by rescued by) crop biotechnology (10 passages). Vaccine bananas and golden rice (each referenced five times throughout the case study coverage) were emphasized as potentially lifesaving benefits for biotechnology. However, several of the articles, such as a 2000 *Washington Post* article reporting on a white-paper critiquing limited global deployment of biotechnology, did recognize that current biotechnology advances were doing little to help "poor farmers in developing countries" during the timeframe of the Bt-monarch issue (*WP* 7/11/00). Largely missing from the discussion, however, were the logistical problems with distributing such miracle plants to the people who need them most, which is the most often-cited barrier to relief of hunger and malnutrition (Bailey & Lappe 2002).

Farmers. In contrast, the benefits to U.S. and developed-world farmers (U.S. and E.U.) were highlighted somewhat less (seven times) in the case study coverage of the Bt-monarch issue, despite the fact that they were the *actual* beneficiaries of Bt- and other GE-crops then on the market. The discussion here focused on how the GE crops made weed and pest control easier for American farmers, thereby helping to increase yields. There were also a few descriptions that indicated the GE plants could be faster growing, cheaper, and stronger, without directly linking how those traits might benefit farmers. Most of the benefit-to-farmers references were mere mentions of the farming benefit, however, and the articles were quick to mention that GE crops then on the market didn't benefit *consumers*:

> It is also true that consumers do not yet see the benefits of genetic modification. The products now out, such as insect-resistant corn and Roundup Ready soybeans, which are impervious to Monsanto's Roundup herbicide, are meant to help farmers. (*NYT* 2/6/00)

Leaving Nothing to Chance. There were a handful of instances within the newspaper coverage where assertions appeared from industry and U.S. regulators promoting the notion that genetic engineering was more precise than traditional breeding. The implication here was that genetic engineering can improve on nature's work, which is messy—and even "chancy" by some human standards. The notion was that traditional breeding couldn't achieve the ultimate good of biotechnology—efficiently and predictably fighting world hunger:

> U.S. regulators and industry representatives argue that engineered food is, if anything, safer than conventional food. Old-fashioned plant breeding involves the random and uncontrolled reassortment of thousands of genes with every mating, they note. By contrast, biotechnology allows the precise transfer of a single well-understood gene into a plant, leaving little to chance. (*WP* 8/15/99)

This notion of precision was carried throughout the case study coverage. The selection of words to describe genetic engineering was important in this regard. Most frequently the process was described as “inserting” genes across species barriers, but was also described as “borrowing” or “altering” code, “adding” genes, or “endowing” a plant with certain abilities—all word choices that evoked a sense of control. The reality, however, was somewhat sloppier. The use of gene guns and micro projectiles is only described once in the case study coverage, and the lone explanation of *Agrobacterium* described the method as a bacterium that “naturally” inserts “the new genetic codes into the plant’s DNA. The cells are then grown to maturity, producing future generations with the desired characteristic” (*NYT* 11/3/99).

The Genie is Out of the Bottle. Another core aspect of the Super Science frame is that this science is already “out there,” and global commercial agricultural cannot turn back from it now (or pursue alternative options). The future world population cannot exist without genetic engineering, and the very thing environmentalists fear with Bt crops—environmental damage—will *inevitably occur without* the aid of GE crops, which will make more food on less land (see the excerpt on p. 203 above from the *WP* 7/9/01, for example).

When a Greenpeace spokesperson suggested that a possible alternative to biotechnology would be to renew efforts to expand organic farming practices that integrated adaptive pest management techniques globally (“‘smarter science and smarter scientists’ were needed to improve organic farming”), he was figuratively laughed off the newspaper page with a quote from a United Nations official from Africa dismissing the notion, saying “Organic farming is practiced by 800 million poor people in the world because they can't afford pesticides and fertilizers—and it's not working" (*NYT* 3/14/00). In one case, a biotech supporter actually insinuated that those who didn't embrace crop biotechnology actually wanted to "put worms back in food" (*NYT* 11/19/99).

The inevitability of biotechnology was most often represented with the reporting of how many acres, or percentages of the total crop acres, of Bt- or other GE- crops were already in the American agricultural fields (15 references across 11 documents throughout the entire span of the newspaper coverage). The newspapers also cited the "meteoric rise" in popularity for GE crops with U.S. farmers (*WP* 1/16/00) and how much revenue GE crops generated for U.S. agriculture. The inevitability was also captured in references to the wide variety of products within the United States that already contained GE ingredients (and had for nearly a decade) and were already available in groceries stores, "just like any other food" (*NYT* 2/9/00). Having established these percentages of GE crops already in the fields and on the shelves of American groceries, the newspaper coverage then linked the issue to global trade, and the potential impact that rejecting these GE crops could have on the U.S. agriculture market:

> Several varieties of genetically modified corn have been rejected by European consumers and others because of environmental and health concerns, costing U.S. farmers more than $200 million in exports last year. With trade tensions rising over the crops, and insect populations holding at modest level in many parts of the American corn belt, some experts were already predicting that sales of engineered corn might decline this spring for the first time. (*WP* 1/16/00)

Presented thusly, farmers, indeed the world, had *no choice* but to accept biotechnology as a key component of global agriculture's future. Michael Phillips, then an executive director in BIO, was quoted reinforcing this notion, "The genie is out of the bottle with regard to the technology" (*NYT* 12/20/99). This "no choice" position appears in two other places within the newspaper coverage—once referencing the monopolization of seeds in the hands of a few multinational corporations, and once linking the technology back to the feed-the-world argument (emphasis added):

> …but one hot question is *whether farmers actually have much choice*. Industry critics contend that the new technology has become so concentrated in the hands of powerful multinationals that they have the marketing influence with international aid agencies *to force some products* on farmers. (*NYT* 12/20/99)
>
> Creators of the products describe them as crucial to feed and ever-expanding global population (6 billion and counting), lowering malnutrition and taming now-incurable diseases. With proper testing and regulation, biotechnology products are safe, [proponents] contend, adding that the world has *no choice but to adopt them*. (*WP* 1/24/00)

Super Problems. Like any superhero with a supernatural power, the "Super Science" element of this frame has a counter frame as well: the "Super Problems" that can arise from a new technology whose potential risks are not entirely predictable. Of course, this "counter" cognitive frame was most accessible through the "Frankenfood" trope (which appears in 11 times across nine articles in the case study), an overt reference to Mary Shelly's Frankenstein and the troubles that humankind can unintentionally create when tinkering with the natural course of life history. The Frankenfood trope was deployed worldwide, and had become a prominent feature of the dissenting voices to the wide-scale acceptance of the "gene revolution," appearing frequently in protests and literature from organized dissent groups.

The Super-Problem counter frame was also evoked in part through 16 references to previous well-publicized eco- and food-/drug- scares, including nuclear reactor problems, the "population scare," exotic invasions (kudzu vine and zebra mussels), mad cow disease, dioxin contamination in food/feed, the unexpected Brazil nut allergies from GE soybeans, and even thalidomide. One Greenpeace news release described the EU consumer concern as akin to people, "avoiding this food like they would mushrooms from Chernobyl," (Greenpeace, "Biosafety protocol: historic step," 1/29/00). The significance of these eco-/food-tragedy references is that none of them were predictable. This unpredictability, like Frankenstein, was cause for much concern amongst some consumers and environmentalists, like Jane Rissler, a representative from the Washington D.C.-based Union of Concerned Scientists:

> This is a very powerful technology that is able to produce combinations of genes that have never been produced before. And it's far from clear what the impact will be on the environment and on humans who consume them. There have been studies that indicate their potential environmental problems." (*NYT* 11/28/99)

Finally, the notion of Super-Problems was also carried throughout the coverage with frequent references the "super" trope to refer to potential ecological problems: "superweeds" (24 passages), "superbugs" (three passages) and super viruses (one passage that mentions increased virulence of viruses in the same passage as "superweed"). The "super-" trope was used to describe the potential risk for increased fitness from gene transfer from GE crops to wild relatives, especially in the case of GE squash. It was also applied to "bugs" to describe increased resistance to Bt from corn borers and other crop pests. The "super"-trope was likely so widely used because it was an easy to convey quickly and efficiently complex ecological interactions, herbicide- /insect- resistance and, to some extent, gene flow to wild species (although there appeared to be general fuzziness with this concept in the newspaper coverage). In any case, the trope was widely deployed to describe the serious risks that needed consideration when deciding how to manage GE crops in association with natural species and landscapes.

The Super-Science frame element answered this Super-Problem counter-frame with the same type of Promethean optimism it viewed as crop biotechnology's future: Science can also solve any potential problems that might inadvertently arise. This philosophy, however, assumes that all risks are knowable, calculable and manageable. The Bt-monarch case presented a new challenge to this assumption, however, since the pre-commercialization risk assessments did not foresee the potential toxicity to monarch larvae before Bt corn was commercialized and planted across North America. Concerned scientists were quick to point this out:

> Dr. Margaret Mellon, director of the agriculture and biotechnology program at the Union of Concerned Scientists, said: "Why is it that this study was not done before the approval of Bt corn? This is 20 million acres of Bt corn too late. This should serve as a warning that there are more unpleasant surprises ahead." (*NYT* 5/20/99)

Despite this apparent failure of the regulatory system (with the recognition of the potential "Super Problems"), the main claim by biotechnology proponents remained that GE crops are unequivocally safe for humans and the environment. For example, Val Giddings, vice president for BIO's crop biotechnology section, made the claim in April 2000 that research to date supported the "generic safety" argument for GE crops:

> "This is a strong affirmation of the academy's previous reports and an emphatic reaffirmation of what the industry has been saying for years, that these products are safe and subject to more regulatory scrutiny than any others in history." (*NYT* 4/6/00)

Crisis of Confidence

The most pervasive media frame employed to negotiate and explain these frames was the "Crisis of Confidence" frame, which appeared in newspaper coverage of the Bt-monarch case throughout the entire timeframe of the case study and captured the obvious tension that existed between the two other dominant frames within the media story. Like both the The Butterfly Effect and Super Science-Super Problem frames, the Crisis of Confidence frame was initiated in the early months of the case study coverage. While there were only two *explicit* references to the consumer "crisis of confidence," several constructions and symbols were employed to develop the frame throughout the case study newspaper coverage. The first references to the "crisis" were described as emanating from the European Union (emphasis added):

> And food scares in Europe over "mad cow's disease," dioxin and Coke, though unrelated to biotechnology, have *fanned consumer worries* about food purity and given a boost to the organic-food movement.
>
> The result has been a *crisis of confidence* in the industry. The companies still believe in the promise of the technology but now wonder whether they will be able to convince regulators and the public that the benefits outweigh the risks. (*NYT* 6/24/99)

> In Europe, that *crisis of confidence* already runs deep. Activists regularly vandalize newly planted plots of gene-altered crops. Major grocery chains have refused to carry engineered food. And food processors have begun to hire DNA fingerprinting labs to verify that their products are free of foreign genes. (*WP* 8/15/99)

Key elements of the Crisis of Confidence frame included the use of the "battle" metaphor to describe the tension that existed between the Super Science—Super Problem and The Butterfly Effect frames and emphasis on a public relations crisis, rather than a real potential ecological problem requiring thoughtful and comprehensive risk assessment and potentially fundamental changes in the U.S. regulatory system. In short, the Crisis of Confidence frame diminishes ecological risk, even as it is the focus of the Bt-monarch story. The central "battle" that was won, in the end, wasn't by *proving* the ecological safety of Bt-corn (and the safety GE crops in general), but by winning over the public trust in both GE crops, and the government-industry structure that regulates them.

The Big Biotech Battle. The most frequently used metaphor for the crisis of confidence was that of battle—specifically the battle for U.S. consumer opinions about GE crops. The use of battle rhetorics was a perennial part of the Bt-monarch story, as was described in Chapter Three (p. 120). An indication of the importance of public sentiment in describing the "battle" was that public opinions were described with great frequency in the case study coverage (p. 102).

In fact, a closer look at the battle rhetorics revealed that most of the time, the anti-biotechnology stakeholders and general public were described as the metaphorical instigator or aggressor of the battle, leaving pro-biotechnology stakeholders, companies and the industry as a whole as the metaphorical victim or defender (emphasis added):

> "The protest industry has gone too far," Edward Shonsey, chief executive at Novartis Seeds Inc., said in an interview. "They've *crossed the boundaries* of reasonableness, and now it's *up to us to protect and defend* biotechnology. As a result there's a combined effort to get the facts out there." (*NYT* 11/12/99)

The subtext of this position was that mis- or dis- information was being disseminated by anti-biotechnology stakeholders, and that a concerted public relations effort by industry would "correct" the problem. The environmental groups' reaction to the industry's public relations solution to the Crisis of Confidence was that it ultimately would not work:

> "They are under the misguided assumption that the more information they put out the more light at the end of the tunnel," said Mr. Rifkin, who is president of the Foundation on Economic Trends, an environmental group. "But the more information they put out the more questions people have about G.M. foods." He asserted that the

> products were dangerous and said, "They think it's a public relations disaster but it's more than that." (*NYT* 11/12/99)

Employing the battle metaphor and its associated rhetorics allowed use of otherwise unacceptable cultural practices and rhetorics as well, such as name-calling and aggression. For example, when two groups have a difference of opinion, the culturally accepted responses are debate, mediation and negotiation. When they are "fighting," on the other hand, the cultural response has much broader latitude, and can include name-calling, aggression and otherwise unacceptable labels and descriptors. In the present case, the battle rhetorics clearly evoked a perceived "aggression" from those in favor of a more precautious approach to commercialization of GE crops, and the battle metaphor helped legitimize the industry response to such "aggression": calling Europeans "Luddite" (*NYT* 12/12/99 and 3/14/00) or the French "fickle" (*NYT* 8/2/99); or utilizing otherwise extreme tactics to compel citizens throughout the world to use GE seeds and food products, such as invoking punitive tariffs or compelling international aid agencies to "force" GE foods on hungry nations (*NYT* 12/20/99). The reporting of the industry claim that anti-biotech arguments, and the European Union, were "emotional" and "irrational" has already been addressed here (p. 193). The name-calling went both ways on the biotechnology battleground, with newspaper accounts of protesters referring to Monsanto as "Monsatan" and "Mutanto" (*NYT* 11/12/99) and the industry metaphorically criminalized: "the industry may be *pulled over* by consumers and *fined* by investors for *recklessly speeding* toward such a future," (*NYT* 12/20/99, emphasis added). However, while the protest groups were called “irrational” for such name-calling tactics, the industry response to protesters was often reported as protecting its interests.

In the context of a public relations “battle” for public opinion, the metaphor allows statements and imagery to be employed in the public relations “campaign,” with little or no qualification. The promotion of GE crops as the only way to feed the world is a case in point. The public relations efforts employed bordered on pure propaganda—discrediting opponents and research that challenged industry and regulatory safety assumptions while promoting GE crops as the only mechanism to deal with problems resulting from an exploding human population. This occurred even at a time when no crops were commercially available to deliver vaccines or higher levels of vitamin A, or to help crops grow in harsh environmental conditions (e.g., salinity or drought tolerance). In the risk-benefit equation under this “wartime” propaganda, risks had to be *proven* by the aggressors, while “defenders” needed to only show that benefits were *possible*. The fact that the technology was not being used for these humanitarian ends at that point in time did not stop the GE crop industry from promoting the GE promises with commercials and advertisements featuring developing world poverty and hunger imagery (*NYT* 11/12/99). There was even a biotechnology industry-sponsored teacher bus tour running during summers in this timeframe (the “Agriscience Bus”), extolling the benefits of GE crops and providing biotechnology “curriculum” and graduate credit for teachers (Garrison 2003).

The industry also portrayed the advocates of precaution as organized enough to develop a comparable, multi-million dollar public relations campaign against the industry and GE crop technology, calling the information provided by concerned scientists and environmental groups, "a vicious public relations campaign," and labeling rag-tag groups of protesters the "protest industry" that was trying to destroy another multi-billion dollar industry (*NYT* 11/19/99 and 11/12/99). The "protest industry" trope appeared at the BIO annual conference in March 2000, in reference to what the industry called "professional protesters" from Greenpeace and Friends of the Earth that were "standing in the way of scientific advances which could help meet the food needs of 1.3 billion people" (Hamilton 2000; AgBioWorld 2001). Labeling protesters as an "industry" with motivations to "do battle" with biotechnology served to legitimize industry attacks on those who expressed concern about potential ecological and human health risks from the new technology. The trope has persisted beyond the Bt-monarch case, and crops up now and again from BIO. For example, according to one 2002 interview with BIO's Val Giddings (emphasis added),

> Activists, says Giddings are part of the *global protest industry driven more by a need for financial gain than education and they are not accountable to anyone.* He believes that they are at the heart of the negative publicity and misinformation and that the global protest industry find it far easier to *raise money by playing to people's fears* than educating them. Keeping activists groups alive is significant *sponsorship from various interest groups* who have much to lose from a global acceptance of GM crops. (Limson 2002)

Over the course of the Bt-monarch case, the battle over public opinion became more complex, as arguments in the media coverage began to question how the commercialization of Bt corn progressed to the level it did before the non-target risk to monarch butterfly larvae was uncovered. In essence, the problem became more than one of assuaging public concern, and evolved into the questioning of regulatory practices for GE crops in the United States. This media questioning began with the Phillips move from an influential position on an NAS panel (examining PIP crops) to head up the policy arm of BIO (evoking the "revolving door" metaphor between industry and the NAS, in addition to the one between the industry and government regulators). The regulatory crisis was then moved forward on the media agenda when Starlink corn was found in the U.S. food supply in the fall of 2000 (after only being approved for animal feed) and the Wolfenbarger & Phifer (2000) paper challenged the rigor of the pre-commercialization risk assessment research upon which U.S. regulatory policy for GEOs was based. Thus in 2000, the newspapers begin to increase coverage of the Crisis of Confidence as one that was more than a mere industry public relations problem, but also one resulting from a decrease in public confidence in U.S. government regulation of GEOs.

From Rubber-Stamping to Road-Blocking. As the media coverage began to delve deeper into the regulatory crisis of confidence, the biotechnology industry and observers also began grappling with a very real possibility that the U.S. government remedy for the crisis might be a restructuring of and increased rigor for its GEO regulatory policy. Critiques (and criticism) of the U.S. regulatory system for GE crops began right from the start of the Bt-monarch case (*NYT* 5/20/99, *WP* 8/15/99) and calls for strengthening regulations—and for enacting a moratorium on GE crop development until ecological risk assessment science could advance sufficiently to address risks—were quick to follow (*NYT* 12/12/99; *WP* 7/9/01). The possibility for regulatory changes took on a global significance in January 2000 when the Cartagena Protocol was established in Montreal. The industry and government regulators responded with concern that new regulations could thwart progress on GE crop development (emphasis added):

> Supporters of genetically engineered crops say such *fears are overblown* and are *creating roadblocks* for a technology that could feed the world and offer a host of other benefits. (*NYT* 11/3/99)

> "The whole world stands to benefit from a sound framework for management of bio-engineered products," said David Sandalow, assistant secretary of state for oceans, environment and science and the U.S. delegation chief. "The *world as a whole stands to lose* if we impose *draconian rules that cost billions* of dollars for little benefit. (*WP* 1/24/00)

Genetic engineers argued that the "flexibility" in the U.S. regulatory process for GE crops was necessary to meet industry commercialization needs, and claimed that the environmental groups' sought *to eliminate* ecological and human health risks altogether—a standard the industry asserted was "impossible" (*NYT* 11/3/99, 2/6/00). Environmental groups and risk assessors, on the other hand, suggested that the current regulatory practices were little more than a rubber stamp. For example, in November 1999 one case study newspaper quoted a Greenpeace spokesperson saying the FDA's performance was "not confidence-inspiring" (*WP* 11/19/99) and the other noted:

> The United States Agriculture Department, the primary agency responsible for assuring the ecological safety of such plants, has not rejected a single application for a genetically engineered crop.

> Scientists who studied the approvals say the department has frequently relied on unsupported claims and shoddy studies by the seed companies. Department officials defend their decisions but acknowledge that their system for weighing applications is evolving. (*NYT* 11/3/99)

Now there was not only a "battle" for public opinion about GE technology, but also an emerging "debate" over how to regulate the technology as well. When the first concrete regulatory change stemming from the Bt-monarch case came about in early 2000 (requiring the planting of non-Bt refuges to slow insect resistance, and perhaps tangentially decrease monarch risk), the biotechnology industry and farming interests called the EPA recommendation for edge-of-field buffers an "unprecedented demand" on the seed industry and farmers, which would be "burdensome" (*WP* 1/16/00). Environmental groups and risk assessment specialists, on the other hand, "praised" the buffer strategy and called it a step in the right direction (*NYT* 1/17/00; *WP* 1/16/00). Note that around this timeframe the battle rhetorics softened somewhat—while four of the five headlines in 1999 included specific references of the battle/conflict metaphor ("skirmish," *NYT* 8/23/99; "take on," *NYT* 11/12/99; "square off," *NYT* 11/19/99"; "march," *NYT* 3/27/00; "food fight," *WP* 11/19/99"), the three of the four headlines that appear in 2000 and 2001 refer to differences of opinion over biotech as a "debate" (*WP* 1/27/00; *NYT* 9/9/01) or a "divisive issue" (*WP* 1/24/00).

Constructing Notions of Scientific (Un)Certainty. The Crisis of Confidence reached into the scientific realm as well. Competing interpretations of what the emerging risk assessment research meant for monarch larvae was captured in newspaper accounts as major differences of opinion between the biotech industry and environmental interests. Environmentalists "seized on" science that supported their arguments for extended risk assessment research (*NYT* 6/24/99); industry was accused of trying to "spin" preliminary risk assessment research findings to influence an EPA permitting decision (*NYT* 11/12/99); and, of course, the prominence given to the anther issue was "troubling" to some research scientists, who believed that the Jesse & Obrycki (2000) research, "simply demonstrated again that one can harm butterflies if you force them to eat enough pollen," (*WP* 8/31/00). The underlying question for the newspaper audience was, can we trust science if the scientists themselves can't even agree on what it means?

The differences of scientific opinion were construed in newspaper accounts as "debates" or "disagreements," rather than "battles." However, the newspapers also sought reactions to the emerging research from environmental and industry groups, which served to magnify differences in the interpretation of research results, obscuring the very legitimate debate about scientific (un)certainty in the Bt-monarch case. The change in verbiage over time toward "debate"—an indication of a more measured and rational disagreement than a "battle"—may have been in part due to the increasing complexity revealed to science journalists as newer ecological research was published about monarchs, Bt corn and other, unrelated GE risk assessments during that timeframe (e.g., Huang et al. 1999, Jesse & Obrycki 2000; Quist & Chapela 2001; Saxena et al. 1999). As the deeper ecological complexity of the Bt-monarch case was revealed, it was increasingly difficult to categorically dismiss concerns about ecological risk as irrational. The notion of substantial equivalence was also becoming more problematic from an ecological perspective, and as the costs for the Bt-monarch risk assessment continued to rise, it became clear that industry and government regulators were unprepared or unwilling to promulgate ecological risk assessments of this magnitude for every potential GE crop to be developed (BIO 10/7/99; Millstone, Brunner & Mayer 1999; *NYT* 12/19/00).

In their attempts to explain the scientific uncertainties that were emerging in GE ecological risk assessment research to the lay public, journalists turned to both university researchers and protest groups for reaction to emerging research. While it's true, as McInerney, Bird & Nucci (2004) point out, that journalists turned to "activist groups" for information during this time, they did so with much less frequency than they did to academic researchers or quasi-governmental researchers (e.g., NAS panelists). Journalists also sought out information from more "established" scientists in policy advocacy organizations, such as those from the U.S. Union of Concerned Scientists. Greenpeace does make the top-10 list for source prominence in this case study; however, a careful reading of attributions to the group rarely reveal the group's position on or engagement in risk assessment science, and most frequently refer to the group's civil disobedience actions or its critique of the U.S. regulatory system. For reliable information about science issues, journalists appeared to consider institutional scientists more credible sources of information than "independent" scientists (Tammpuu 2004, p. 198).

However, in the course of the Bt-monarch risk assessment, even the "establishment" scientists didn't agree on all aspects of the risk assessment research and drew different conclusions from emerging evidence throughout the course of the case study coverage. For example early in the case study, lab tests were not considered as informative as field research, because the variables that exist in the field (e.g., wind, rain, natural degradation and other mortality factors) likely mitigate the risks found in laboratories (thus, the critique of Losey, Rayor & Carter 1999). However, when increased mortality was found in a modified field study (Jesse & Hanson 2000), the results were dismissed by other credible risk assessment researchers because the pollen found in the field was not purified, and contained anther fragments (anthers are naturally found in field conditions; laboratory toxicity studies used purified pollen). The scientific uncertainties that emerged left newspaper accounts concluding that there was still a lot to be learned about GE crops and ecological risks. Not at all confidence inspiring in the face of a small federal ecological risk assessment budget and an industry committed to its position of substantial equivalence.

Cultural Frames

Beyond the cognitive frames that told the immediate story of the Bt-monarch case, broader and longer-lasting cultural frames were also evoked through the newspaper coverage. Recall that *cultural* frames are enduring and deeply held cultural constructs that can be easily “called up” in the popular culture through symbols and rhetorical tools. One of the unique characteristics of a cultural frame, according to Reese, Gandy & Grant (2001), is that its constituent parts need not be frequently employed, as the symbols and rhetorics used to construct it are so widely accepted that it may only take one or two references to the frame to evoke its salience amongst media consumers.

Cultural frames do not subsume cognitive frames, but they are more enduring than the situational cognitive frames—and are readily recalled in public and media discourse throughout time. Like cosmologies, cultural frames are based on core cultural beliefs and influence the way problems are constructed by acting as a cultural lens through which interpretation of all events pass. These cultural frames present the dominant way a population views and understands the world. Cognitive frames are more or less the immediate (and intermediate) triggers for these more enduring cultural frames. For example, while two U.S. social actors with different points of view on biotechnology may react to The Butterfly Effect cognitive frame differently (an “anti-biotech” actor might understand it in terms of “fragile ecology”; an industry representative, as threatening financial chaos), they achieve a shared understanding of the frame because it is presented in the mutually well-established context of the U.S. political democracy and a free-market economy. Where cosmology is an *individual’s* way of knowing; a cultural frame is reflective of a *population’s* predominant ways of knowing.

Detailing the complex interactions between American culture and genetic engineering is beyond the scope of this research (see for example, Gottweis 1998 for a comparative cultural study of genetic engineering in Europe and the United States in the years preceding the Bt-monarch case). However, the present research did uncover some connections between the Bt-monarch case and dominant cultural tenets operating in the United States. These broader cultural frames have some fairly obvious connections to the cognitive frames discussed above. The Super Science-Super Problem cognitive frame evokes a broader cultural frame, "Science as Savior"—the notion that progress through the advancement of science and technology is an unquestionable goal of American society. The Butterfly Effect and Crisis of Confidence cognitive frames evoke the culturally agreed-upon economic premise that free market forces will be the deciding factor in determining whether a particular technology will succeed or fail in the marketplace of ideas—both at home and abroad. In the context of these cognitive frames, "The Free Market Rules" cultural frame ultimately positions the United States as the leader of the free world and global economy. Because these cultural frames build on the connections between document nodes and cognitive frames already developed above, the reporting of these cultural frames here will focus on describing their central notions (i.e., beliefs generally held to be true) and outlining some of the more obvious connections between the case-study documents and cognitive frames. Two "reverse discourses," emerge within the case study to challenge the central notions of these predominant cultural frames, one emphasizing systems-oriented science; another, the precautionary principle. Because these notions don't "fit" easily with (or even challenge outright) the central notions of the broader U.S. cultural frames, they are largely under-represented—or even marginalized—in the media accounts of the Bt-monarch case. Discussion of these reverse discourses are addressed as challenges to the dominant cultural frames.

Science as Savior: Risks are Reduced by Science

The Science as Savior frame is premised on the cultural notion that progress and growth *must* continue in order to move humanity toward a utopia where everyone enjoys high living standards and freedom from intensive pursuit of food and water (see, for example, Stewart & Milton 1991, pp. 119-125 for a brief history of this central U.S. cultural notion). Humankind must be moving toward something bigger and more advanced or it will stagnate, the notion goes. Free-market economic systems must be growing, or they to will falter and fail to produce further innovation. Innovation will get humankind closer to utopia, as well as save it from missteps and challenges that might arise along the way. According to Stewart & Milton, in the United States

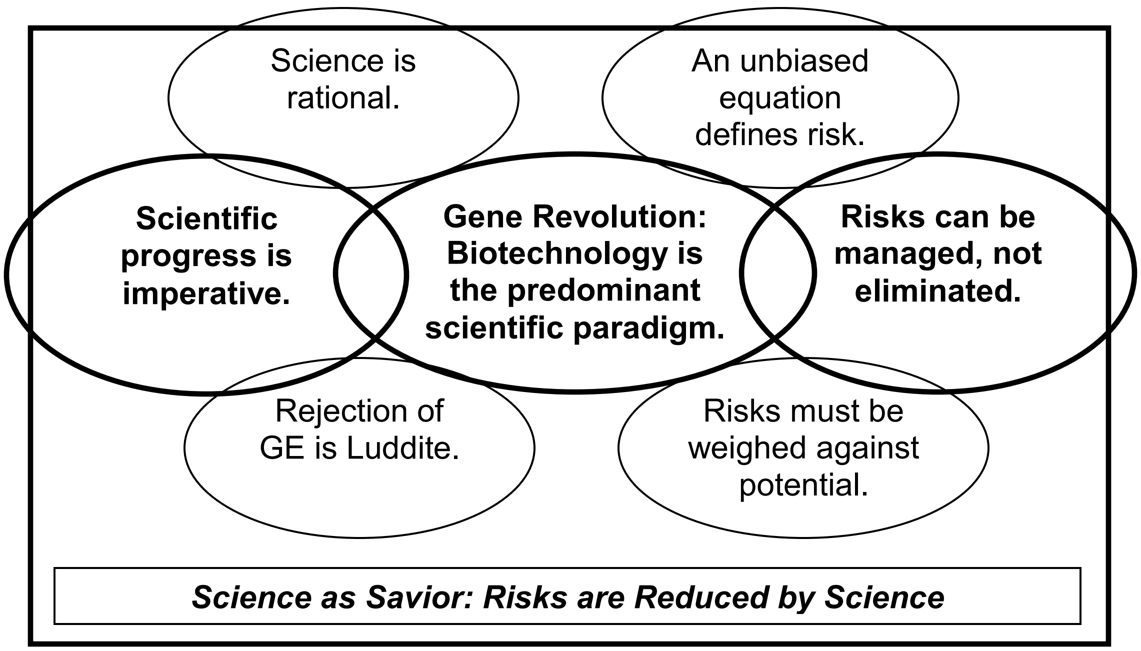
> The belief in human perfectibility and progress takes precedence over the doctrine of original sin, which acts more as a reason to change and improve than as an immutable condition—human beings can change and improve, and it is their duty to do so. The implied agent in American culture is transformed by experience into a rational manipulator and controller of the environment. (p. 114)

In terms of the Bt-monarch case, the Science as Savior frame emerges in three central cultural notions: 1) Scientific progress is imperative; 2) Biotechnology is the predominant scientific paradigm; and 3) Risks can be managed, not eliminated. Supporting cultural notions at play—and called upon—in the case study documents include: 1) Science is rational; 2) An unbiased equation defines risk; 3) Rejection of GE is Luddite; and 4) Risks must be weighed against potential.

The supporting cultural notions serve as bridges from the cognitive framing of the Bt-monarch case to the broader cultural frames. Figure 4.4 provides a visual representation of these central and supporting cultural notions. While these central cultural notions were evoked through the various metaphors, images, rhetorics, tropes and symbols used to construct the cognitive frames in the mediated discourse, they are also *constrained* by incongruent activities and events that emerged throughout the case study, which highlight some of the cognitive and cultural tensions that sustained the Bt-monarch story on the media and public agendas.

Reductionist vs. Systems Science. The “Science as Savior” cultural frame has an important subtext that explicates its central notions: Risks are reduced by science. Thus, not only is scientific progress culturally imperative to advance human circumstance, but it is also necessary to save it from social and environmental problems. Here, the verb “reduce” has two important constructions: 1) the lessening or removal of risk from society and the environment, and 2) the process within the realm of scientific inquiry that examines systems by breaking them down and studying them through their constituent parts (or, “reductionism”). Thus, the tension that exists with this cultural frame comes from a now-emergent, and competing, science-based "reverse discourse," deeply rooted in the fields of human ecology and sustainability studies that emphasize relationships between organisms (including humans) and the biotic and abiotic environment.

Figure 4.4 *Science as Savior* Frame: Central and Supporting Cultural Notions



Note: Dark circles are central notions of the cultural frame. Lighter circles are supporting notions that case study cognitive frames present as connectors to the broader cultural notions and frame.

This systems-oriented approach to scientific inquiry advances the notion that "solving our acute environmental problems will require the intelligent application of general principles of ecology within the framework of political, economic and social action," (Ricklefs 1996, p. 25). While not abandoning the core notion of scientific inquiry, this reverse discourse does subordinate the notion within a broader, human socio-economic context. The systems-oriented counterframe takes analysis one step further than reducing scientific inquiry to a problem's constituent parts, but also explores how those constituent parts impact whole systems, as well as how human social and economic institutions influence and impact those systems through biotic and abiotic interactions (see, for example, Senge et al. 2004). This systems-oriented inquiry also aims to "advance" humankind and ecological health through "sustainable" development and agriculture, rather than pursue the industrial form of agriculture initiated by the Green Revolution. Thus, one of the cultural tensions brought to the fore by the Bt-monarch case is of competing notions of what kind of science will ultimately be the "Scientific Savior"—one that is based on a reductionist-science approach or another that is based on a systems-science approach. The systems-oriented counterframe appears frequently in supporting research documents from the E.U. newspapers, sustainable agriculture literature, Greenpeace news releases, and statements from the Union of Concerned Scientists, but is nearly absent from the U.S. newspapers studied in this case (discussed further below).

Sole Savior. The Science as Savior cultural frame situates two very different sciences—genetic engineering and ecological risk assessment—within a pervasive modernist notion that posits that humankind will always be able to rely on advancements in science to mitigate the problems that human population growth and development impose upon the natural world and, by extension, our own species vis-à-vis food safety and agricultural chemical exposure. In other words, Science can save us from ourselves (See the "Super Science-Super Problem" cognitive frame, p. 198).

Thus, the notion of a Savior is employed here, which has overt religious significance in the United States, a country founded on Protestant notions that human beings were the creators of their own destiny, “civilization” was to be the central instrument for perfecting humanity, and where the Christian influence is still culturally pervasive (Stewart & Bennett 1991). The colonists viewed survival as a “virtual fight” against wilderness, which sought to thwart early farming efforts. New World diaries and literature, for example, are replete with battle metaphors that describe colonists’ struggles against the natural world.

In a largely monotheistic culture dominated by a central spiritual savior figure, the notion that there is *only one way* to save the planet from certain destruction—through scientific advancement—holds cultural sway (see also Nelkin 2001 for a discussion of geneticism and the Christian notion of a “sacred identity”). The science of agricultural genetic engineering was thus situated through this central Science as Savior cultural frame as *the only way* humankind would be able to feed a growing (global) human population without destroying the natural world. The “reduction” in this realm has four constituent notions—or cultural myths—that orient the frame toward genetic engineering as a “Sole Savior”:

1) Genetic engineering reduces the risks from monotypic agriculture to ecological systems by requiring fewer chemical inputs and by producing crop enhancements that increase productivity on existing agricultural lands (and thus, do not require further wild land conversion).

2) Genetic engineering reduces the risk of human hunger and the associated negative consequences of malnutrition by providing crop enhancements that increase productivity (make more food available) and nutritional value (make higher-quality food available).

3) The solution to world hunger, framed thusly, is not to take into account a system-level view of global food distribution and rotational cropping/ integrated pest management (IPM) systems (macro-level), but to employ a singular, micro-level approach that focuses on genetic improvements to crops that will further advance existing agrochemical-based crop systems.

4) By combining the above central aspects of the frame, the universe of possible solutions for the world hunger/land conversion problem is limited to genetic engineering, and dismissive of other system-level problem solutions.

The science of ecological risk assessment was similarly situated within this Science as Savior frame with aspects that also evoked the "Savior" notion. Here, the assumption is that risk assessment is a very rational, defensible and science-based approach to mitigating ecological risks that might arise from GE crops:

1) Science-based risk assessment is capable of explicating, and then mitigating ("reducing"), risks to ecosystems that stem from the deployment of another technological advance, GE crops.

2) Science-based risk assessment is an objective way to evaluate non-target risk by breaking it down to its constituent parts—toxicity and exposure—and defining the acceptable risk to a species through a single probability of mortality that is derived from an unbiased mathematical equation. Note that this reduction to a single-species risk assessment (micro-level) ignores ecological dynamics (system-level) that may (or may not) be influenced by impacts to a single species, not to mention possible impacts to multiple species.

3) The now-dominant notion of adaptive natural resource management makes risk assessment the *only* paradigm through which a risk society can reasonably deal with GE. Because the technology is already "out there," a GE future is inevitable the notion goes. Risk *reduction* (i.e., proactive management or avoidance) through alternative agricultural practices is impossible. Risk *management* (i.e., reactive management or mitigation) through reductionist assessment methods is the only option under the adaptive natural resource management paradigm. (Andree 2002 provides a detailed historical deconstruction of this aspect.)

Gene Revolution: Biotechnology as the Predominant Scientific Paradigm. The most central of the cultural notions within the Science as Savior cultural frame, "the predominant scientific paradigm" notion, was evoked through a number of rhetorical strategies and symbols, and particularly through the Super Science-Super Problem cognitive frame. The central rhetorical device deployed to evoke this notion was the trope of the "Gene Revolution" as the natural extension of the "Green Revolution"—a reference to the post-war development of improved seed varieties and agro-chemicals in an effort to increase production on cultivated acres as part of a global effort to curb world hunger. The trope of the "gene revolution" is only explicitly referenced once, late in the mediated discourse of the Bt-monarch case study:

> Despite enormous population growth, [the green revolution] cut the malnutrition rate from 40 percent to 23 percent. What the green revolution began, the gene revolution can continue. (*WP* 7/9/01)

However, other symbolic strategies were used to evoke the reference prior to this explicit *Washington Post* editorial, and the trope was also being used elsewhere during the case study timeframe (e.g., Serageldin 1999). Besides the *WP* editorial above, two other articles referenced GE crops as the "new" green revolution (*NYT* 2/6/00 and *WP* 7/11/00), and also made persistent reference to "feed the world," a popular slogan in the 1960s green revolution:

> Without gene modification technology, the [Third World Academy of Sciences] report concludes, it will be impossible to feed the world's poor in the future without destroying the environment. (*WP* 7/11/00)

Variations on the feed-the-world rhetorics appeared in the BIO news releases, including: "feeding hungry nations," "feeding growing populations," "feed and clothe families" and "increase the world food supply" (BIO 11/18/99, 1/21/00, 4/3/00, 4/5/00, and 6/30/00). The feed-the-world references also appeared in the Greenpeace news releases and UCS Web site content as well. While these references were commonly presented as unsupported claims by the biotechnology industry, the references support the notion that the trope was a predominant part of the dialog about GE at the time of the case study.

The predominant paradigm notion was also supported by some other rhetorical devices and symbols employed within the case study coverage, including the superhero imagery and rhetorics throughout the media coverage. These symbols and rhetorics are set up both in the affirmative, futuristic imagery and rhetorical devices of "superheroes"—but also in the contrasting images and rhetorics of enemies and eminent threats ("Frankenfood" and "killer corn") put forth by environmental groups, GEO opposition groups and protesters. Frequent imagery of the double-helix genre also supported the notion that genetic technologies were an integral part of the predominant genetics-focused scientific paradigm: a double-helix as the core of an apple in a line-art illustration (*WP* 6/14/00) evokes the reduction of the apple's identity to its most basic genetic components; a double-helix symbolically subsumes an ear corn by encircling it with its very own genetic components (*WP* 8/15/99); a mock-up food label with the open-ended double-helix at its center, suggesting an unlimited, and inevitable, centrality of GE into the future (*NYT* 11/12/99). As Nelkin (2001) pointed out, during the time of this case study, genes and genetics had become not only the essence of personal identity (ala the human genome project), but also the "Holy Grail" predicting the fate of all forms of life on Earth.

For its part, BIO sponsored the notion that biotechnology was the predominant scientific paradigm, asserting in many of its news releases that the technology held great promise in resolving world hunger and health problems. BIO news releases also sponsored the definition of GE agricultural products as “crops *improved* through biotechnology” (emphasis added) and also proclaimed them, “new,” “enhanced” and the “crops of the future”—while at the same time maintaining for regulatory purposes that they were “substantially equivalent” to traditionally bred crop varieties. Midway through this case study, BIO celebrated the presidential decree that January 2000 was National Biotechnology Month with a news release proclaiming biotechnology’s primary role in nearly every future technological advance:

> Carl B. Feldbaum, president of the Biotechnology Industry Organization (BIO), said, "Biotechnology is at the center of almost every effort to improve our health care, agriculture, industrial manufacturing and environmental management.” (BIO 1/21/00)

Given such exuberance for GE crops, it was difficult for alternative frames to find a place in the U.S. newspaper coverage (see “Context is Everything” below, p. 241). The instances that questioned *whether* humankind should pursue a GE future were limited to one week-in-review article, headlined “We can engineer nature. But should we?” (*NYT* 2/6/00), and some limited discussion in a *NYT* article about scenario-building exercises (6/24/99). Alternative, systems-oriented visions for technological “progress” were virtually absent from media discussion. In media accounts the takeaway message was that Progress will be defined by the future of genetic technologies.

Scientific Progress is Imperative. Another very central construction of the Science as Savior frame is the notion that scientific progress is imperative for advanced societies (Nelkin 2001). The logical extension of this core cultural notion, according to Proffitt (2004), is that today's U.S. agricultural production system is thoroughly entrenched in technologically demanding solutions for increasing agricultural production, and indifferent or hostile to alternative solutions that would require fewer chemical inputs (see, for example the reaction to a Greenpeace suggestion of the same in *NYT* 3/14/00—described on p. 206 here). Genetic engineering is the logical extension of a cultural worldview that seeks input-intensive, technical solutions for its problems. Geneticism is taken for granted as the "map" or "blueprint" of the future—objective and pre-determined by the genetic codes that make up all forms of life (Nelkin 2001). Industrialization of agriculture, increasing chemical inputs, and concentration of crop genetic resources into the hands of a few multinational corporations are key components of the "magic bullet" approach that will revolutionize agriculture in this worldview (Altieri & Nicholls 2001). Within this context, alternative solutions are, "simply not a viable solution in the institutional logic of the field, which, in addition to the corporate profit motive, also involves large labs, expensive equipment and large numbers of well-trained scientists," (Proffitt 2004, p. 60).

In newspaper coverage of the Bt-monarch case, the imperative is recalled through descriptions of the GE crop technology as "promising;" suggestions that indicate that GE is *the only way* to feed a growing world population; and a near-absence of discussion about alternative agricultural practices. A general sense of *inevitability* for GE agriculture was also an undercurrent throughout the media coverage, with frequent references to substantial percentages of the total corn acreage already planted to GE varieties and comments about the multi-billion dollar industry that had amassed in order to move the GE crops forward on the global agricultural landscape. Information on Web sites from leading direct sources cited in the newspaper coverage also described the inevitability of the "Gene Revolution." In a letter to then-Secretary of Agriculture Ann Veneman regarding the NAS report, *Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation*, the UCS (identified as an anti-biotech stakeholder in some newspaper coverage) signals the imperative (note the inevitability in verb tense, emphasis added):

> The next generation of agricultural biotechnology products *includes* the so-called pharmaceutical and industrial crops, which *will be used* to produce drugs and industrial chemicals. Although such plants promise important benefits like cheaper drug prices, their risks *will be far* more varied and difficult to assess than the herbicide-tolerant and Bt crops of today. ("To USDA: Implement NAS" 2002)

While the charge toward a GE future was undoubtedly governed by well-intentioned motivations to increase the reliability of industrial food production, others argued that as it was then progressing, crop GE would likely continue or worsen the negative ecosystem impacts occurring in the monotypic, high-input agriculture regimes of the Green Revolution (Anderson 1999). To answer this charge, some sources in case study articles suggested that to challenge a GE future was to stand in the way of scientific and agricultural progress:

> "In an ideal world you'd know all the risks and all the benefits before you use something," said Dr. Herb S. Aldwinckle, plant pathologist at Cornell University, "but we'd be very slow to progress if we had to know all that." (*NYT* 11/3/99)

Key to understanding the Science as Savior cultural frame is the American belief that rational thinking is based on an "objective reality," where observable facts are revered as "valid" on account of their objectivity and measurability. Consequently, American rationality avoids the perceived "deficiencies" of intuition and "common sense" in practices like problem solving and conflict management (Steward & Bennett 1991, p. 32). As is evident in the Super Science—Super Problem cognitive frame, advanced science was presented as the "rational" way to address both world hunger problems and the ecological risks GE might present. Pro-biotechnology sources often emphasized the "lack of evidence" of ecological or health risks, and proclaimed GE crops to be well studied and researched. By contrast, "irrational," "emotional" and even "Luddite" were the labels used to describe those who challenged this central cultural notion with "common sense" notions of precaution and sustainability. There was little discussion in the newspaper accounts that an alternative conception of rationality was being championed in Europe and some developing countries, involving the precautionary principle and continued investment and innovation in sustainable agricultural practices. Such approaches were incongruent with the predominant U.S. cultural conception of progress, which tended to emphasize that, "the basic problems of the world are economic and that technology offers solutions," (Stewart & Bennett 1991, p. 121): Progress would come in the form of more sophisticated GE crops and ecological risk models.

Risks can be managed, not eliminated. The Bt-monarch case did give U.S. citizens a reason to pause and consider the potential unintended consequences of the scientific progress imperative, however. Beck (1992) had already begun discussing the notion that ours had become a "risk society"—recognizing that in order to realize greater comfort and stability, we'd also have to accept more risks from new technologies (Andree 2002; Song & M'Gonigle 2001). The Bt-monarch case was perhaps the first widely publicized ecological risk from a commercialized GE crop to force U.S. consumers to recognize the "innocents" that weren't typically part of corporate cost-benefit equations. Thus, the monarch larvae became the first publicly identifiable indication of a flaw in the U.S. regulatory policy based on substantial equivalence.

According to Wrubel, Krimsky & Wetzel (1992), when the doctrine of substantial equivalence was accepted early on in the field trials of GEOs, the levels of genetic contamination that were acceptable in traditional plant breeding were *ipso facto* accepted for GE crops—based largely on early reports from the NAS (1987) and NRC (1989). The doctrine essentially cuts off further environmental assessment, because once substantial equivalence is determined, there is no need to explore risk and consequences further. Andree (2002) points out that because genetic engineering was long ago organized in terms of *risk discourse* (which we strive to *manage*) rather than *hazard discourse* (which we strive to *eliminate*), five important "ecopolitical" ramifications emerged to govern GEOs in North America: 1) the overall cost/benefit equation puts the burden of proof on critics of the technology; 2) it is assumed that all risks are calculable; 3) risks are framed in terms of manageability rather than avoidance, 4) unanticipated risks are implicitly considered manageable; and 5) GEOs are assumed to be fairly traded, thereby distributing risks and benefits from the technology equally.

By the time potential toxicity was discovered for monarch larvae in 1999, however, many ecologists had already begun to recognize that much of pre-commercialization research lacked sufficient detail and was based largely on literature reviews, rather than experimental data. Thus, the science that had been used to make policy decisions up to that point was publicly thrown into question and could not point to a clear course of action (Song & M'Gonigle 2001). It also made problematic the notion that GE was simply a linear and "natural" progression from traditional plant breeding (Andree 2002).

According to Stewart and Bennett (1991), Americans are more committed to technological solutions (or, "technicism") than any other culture, and tend to view progress as the natural evolution from more primitive human practices and existence:

> The American social norm of progress incorporates a number of assumptions, among them the basic one of lineal time. Progress is associated with the view that time is like a river flowing in one direction from its source to its mouth…With the scientific support of the theory of evolution, Americans see progress as ascending from the primitive past along a path in time toward a future in which the impediments of nature are dominated by individual human will and technology. (pp. 123-125)

Prior to the Bt-monarch case, GE could be readily conceived of as an important linear (rational and intuitive) advancement of traditional agricultural breeding practices, rather than the "radical new technology" or "living toxins" described in other supporting documents examined in this case study (e.g., Greenpeace 5/20/99; UCS 10/18/00, "Frequently asked questions about biotechnology"). Such linear cultural reasoning was, of course, the basis of the application of the widely accepted, single-species risk equation [Risk = P(exposure) x P(toxicity)]. It was by this equation that Bt's non-target risk was ultimately evaluated, and exonerated, in the Bt-monarch case. While systems-level risk analysis of Bt crops was emerging at the time of the case study (e.g., Altieri 2000; Obrycki et al. 2001; SWGB 1998), it was little reported in the newspaper coverage.

Reliance on the P(e) x P(t) risk equation as the predominant risk assessment method assumes that all risks are knowable and that the only significant metric at the population level is mortality (toxicity). Part of the cultural tension created by the Bt-monarch case existed because the accepted risk assessment framework broke down—failing to adequately assess some potential ecological risks from Bt corn: sublethal impacts were ignored; in-field toxicity from anther fragments, dismissed; multitrophic interactions, unstudied. During this timeframe, not only were the non-target monarchs perceived as threatened by the corn, but threats to the security of the U.S. food chain (Starlink) and native maize germplasm (Quist & Chapela 2001) also emerged as possible unintended consequences from Bt corn that could not be detected by the unbiased risk equation or U.S. risk assessment framework.

Perhaps not surprisingly, it was within this broader cultural context that culturally defensive arguments about the (un-) reasonableness of *eliminating* risk emerged in the media discourse (e.g., "science can never assure safety with 100 percent certainty" *WP* 8/15/99). Because American culture frames progress as imperative, the notion that Americans could collectively decide to proactively *eliminate* the potential ecological risks from GE crops by issuing a moratorium on their development was preposterous. In fact, only five mentions of a GE moratorium appear in U.S. newspaper coverage, three of which pertain to calls for such in the European Union. As discussed above, a GE future was framed as virtually "inevitable" by the U.S. media and key stakeholders.

Instead, the focus was on "minimizing" or "managing" GE risks, with a constant eye toward the potential benefits GE might present. As such, some 60 passages were coded to the "Bt benefits" and "Biotech benefits" nodes from the case study newspapers—potential that was being industriously marketed by biotechnology companies and industry sources during the case study time period (nearly every BIO news release examined included some statement of potential benefits from GE). And, while there were 26 passages coded to the "Federal regulations are inadequate" node, those were more-or-less neutralized in the media coverage with 14 passages describing federal regulations as adequate and nine describing them as burdensome. Rather than eliminate the risk entirely, or over regulate the technology and thereby thwart innovation, far better, the cultural frame reasons, to weigh potential risks from GE crops against their potential benefits.

The "risk management" notion of the Science as Savior cultural frame is consistent with what Zavestoski et al. (2004) call the "caution-not-alarm" frame, which downplays environmental threats and encourages a "sensible" rather than "panicked" reaction from the public. By adopting this frame of "managing" rather than "eliminating risk," journalists have also assumed a "scientific conformism," failing to critically examine the cultural assumptions and rhetorical devices used by leading sources of information in their articles (Zavestoski et al. 2004). For example, a moratorium (*eliminating* risk) is something advocated by irrational special interests (ala Jeremy Rifkin, *NYT* 6/24/99 or PIRG *NYT* 8/23/01) or "emotional Europeans" (*NYT* 3/14/00, 6/27/99). Focusing on the "fixing" the regulatory system and risk assessment framework is a far more sensible approach to dealing with the apparent challenges to this predominant U.S. cultural frame.

In the end then, the media accounts of the Bt-monarch case largely portrayed GE as the only way forward for global agricultural advancement. Mitigation of potential threats would happen through good science, which would be sought through refining crop genetic engineering and employing existing ecological risk models to confront risk. By September 2001, Bt had been exonerated from causing harm to monarch larvae by application of the traditional risk equation, and the media had subdued the reportage of anti-biotech interests' portrayal of GE as a potentially "mad science" and "Frankenfoods" as the folly of scientific hubris. Underplayed in this media wrap-up, however, was an alternative "reverse discourse" for understanding scientific progress.

Context is Everything: A Reverse Discourse. From the perspective of some systems-oriented scientists, GE did not appear to be bringing about the agricultural "revolution" that would yield improvements to long-term sustainability or creating real promise for food security worldwide (UCS 10/18/00, "Frequently asked questions about biotechnology"). The most widely planted GE crops at the time (insect- and herbicide-tolerance), in their view produced environmental benefits that were "minor" and "short lived" at best, and at worst had not done anything to help the world take "a fundamentally different pathway in agriculture" or had "produced only minor reductions and substitutions in pesticide use in an agriculture that continues to be pesticide-dependent."

Those who rejected the inevitability of GE as the answer to global food security often cited crop rotation and agricultural infrastructure improvements as more sustainable alternatives to monotypic agricultural practices (with its attendant heavy chemical inputs and high-erosion tilling practices). However, as the UCS Web site pointed out, shifting from industrial to sustainable agriculture would "eliminate the need" for many of the GE crops then on the market, because the systems approach to sustainable agriculture would involve adjusting elements within the agricultural system, rather than "developing new products that must be purchased" (10/18/00, "Alternatives to genetic engineering"). So too was the U.S. regulatory system entrenched in an administrative-industrial paradigm. According to Andree (2002), the regulatory "facts" had been established by "bodies firmly committed to an industrial reshaping of the living world and the ever-expanding management practices this assumes are possible," (p. 165). To answer those who claimed that such systems approaches wouldn't work at the scale necessary to feed a growing world population, like the African FAO official in the *New York Times* (3/14/00), those holding the sustainable agricultural worldview believed the approaches hadn't yet been seriously tested, because there were no industrial constituencies to support large-scale trials of such concepts.

Some promoters of sustainable agriculture saw little reason to conclude that genetic engineering would be a major improvement over the more sophisticated forms of traditional breeding. According to the UCS Web site at the time,

> Early 'gene dreams' were of nitrogen-fixing crops, higher intrinsic yield, and drought tolerance. But so far none of these seems realistic because most involve complex multigene traits. For the most part, genetically engineered crops are limited to one or two gene transfers and have relative few applications of use to hungry people. (10/18/00, "Biotechnology and the world food supply")

Sustainable agriculture is not mentioned at all within the case study articles; in fact, the word "sustainable" is used only twice in the case study newspaper documents—both in passing reference to sustainable development in a *NYT* article (6/24/99) about a biotech industry scenario-building exercise. When "organic" farming is mentioned in the case study newspaper articles, it is most frequently in relation to the problems organic farmers will have with pollen drift from nearby GE fields, resistance to Bt sprays in the future as a result Bt agricultural crops, or the effort to keep organic labels exclusive of GE ingredients. Thus, the related notions of "organic" and "sustainable" agriculture were very much positioned as the "other" or "alternative" form of agriculture. Industrial agriculture was normalized in the newspaper coverage; sustainable agriculture was marginalized or even delegitimized. In one extreme example of this delegitimation of sustainable agricultural practices, a European newspaper was quite explicit in the normalization of industrial agriculture, when it quoted Sir Robert May, a leading ecologist in Great Britain, proclaiming (emphasis added)

> "And don't forget that Bt is used by organic farmers *as well as normal farmers.*" … The mention of the O-word triggers another spasm. "Of course, *organic farming is a theological movement*," he growls. "It has nothing to do with biology. The people who run the movement think that if you put what they call natural poisons in the soil that is OK. Yet some of the stuff they use is really nasty, but is deemed OK *by the Ayatollahs that run the Soil Association and who rule the organic farming movement.*" (*London Observer*, 5/23/99)

In fact, the notion of sustainable agriculture was discussed at some depth in supporting documents available to journalists at the time of the case study. The

Union of Concerned Scientists, a leading direct source of information for the newspaper articles, featured sustainable agriculture alternatives prominently on its Web site, as did Greenpeace:

> Much can be done to promote the sustainable intensification of agricultural production. Most of it should be done in developing countries to enable people to feed themselves so that they do not become dependent on commodities from abroad. All of it depends on local climates, cultures, and economic conditions. … Among the many research areas important for increasing production are the efficient use of irrigation water, crop improvement through traditional plant breeding, and new ways to manage crop-pest interactions, such as integrated pest management. (UCS 10/18/00, "Biotechnology and the world food supply")

> "The UNDP of all agencies should know that complex problems of hunger and agricultural development will not be solved by technological 'silver bullets'. The real crisis is the obvious neglect of research and investment in the further development and spread of sustainable and ecological agriculture technologies," added [Von Hernandez, Campaign Director for Greenpeace in Southeast Asia]… Instead of naively advocating the export of ill-devised and unsafe GE technology in the South, agencies like the UNDP should concentrate on the dissemination and promotion of proven and sustainable methods to improve agricultural practices." (Greenpeace 7/10/01)

The predominant cultural frame, however, dismisses sustainable agricultural practices as somehow primitive and a step backward from higher civilization and "advanced agriculture." Perhaps even more dangerous than the dismissal of sustainable agriculture from the media discourse about global food security issues is the threat that our dominant cultural frames may limit the scope of our thinking about global agriculture and GE's role in it. The Science as Savior frame—as currently constructed—narrows and simplifies the range of possibilities the United States might consider to confront human social problems in the future. Such "geneticization" or "genetic essentialism" relegates the social, political and economic factors contributing to world hunger and environmental destruction to secondary importance, even though many of these factors may in fact be root causes (Bailey & Lappe 2002; Tammpuu 2004). Further, as Torgerson (1998) aptly argues, the conventional regulatory structure is built from this cultural frame, and thus perpetuates and promotes this "modern vision of progress," (p. 110) and a self-replicating "continuous process of government-facilitated economic expansionism" (Song & M'Gonigle 2001, p. 983). While ever a strong advocate for GE crops, even Agriculture Secretary Dan Glickman made tacit recognition of this problem in the midst of the Bt-monarch case:

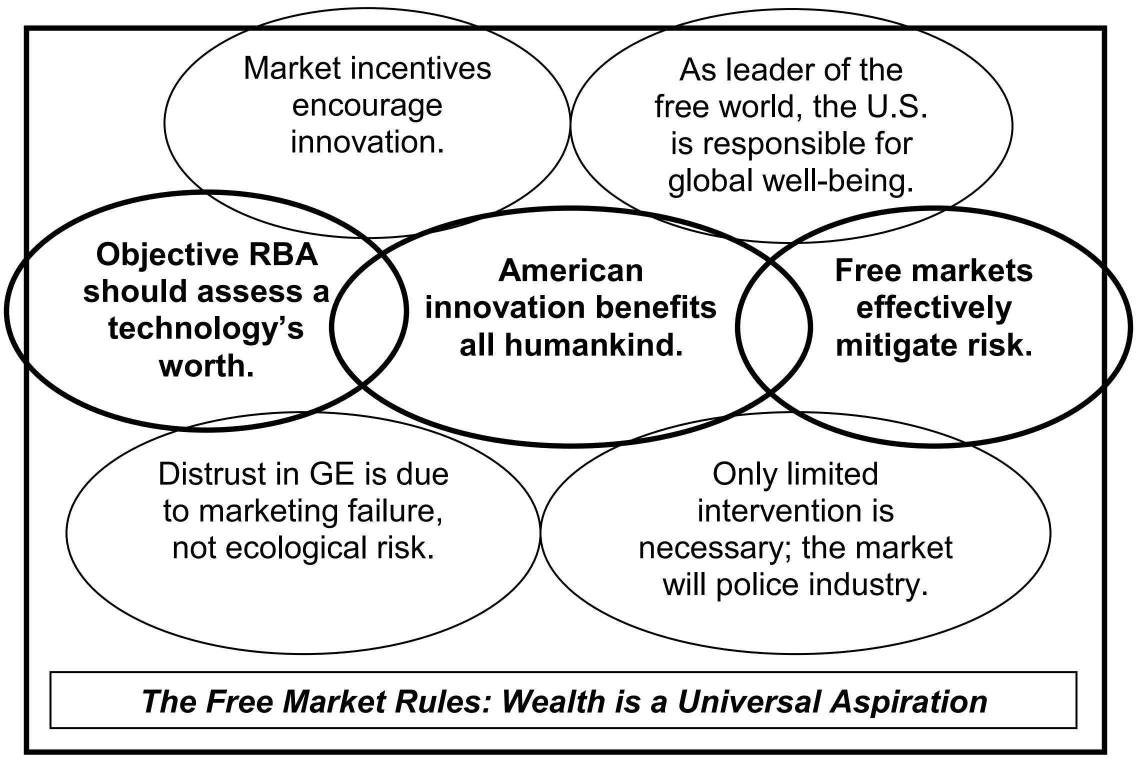
> He [Glickman] compared biotechnology today to nuclear power 20 years ago, saying: "We have a way in this country of latching on to solutions, pursuing them to the exclusion of others, and then watching them sometimes backfire. We did that in the late 70's, when we embraced nuclear power as the primary source of our energy needs. Then, Three Mile Island happened. Now nuclear power is still part of our energy grid, but it's not the only part."
>
> "Let's not put all of our eggs in the biotech basket," Mr. Glickman added.
>
> It is a comparison that the biotech industry considers invidious but opponents believe is not. (*NYT* 7/14/99)

The Free Market Rules: Wealth is a Universal Aspiration

The central cultural notions of The Free Market Rules frame are 1) that a straightforward (i.e., rational) risk-benefit analysis can objectively assess a prospective technology's worth to society; 2) that market dynamics will ultimately self-regulate whatever technologies come to the marketplace (and hence, remove risks that society is unwilling to take); and 3) that advances in American technologies will benefit humankind across the globe (Figure 4.5). Supporting notions that link the Bt-monarch cognitive frames to the broader cultural notions included 1) market incentives encourage innovation; 2) limited intervention into the market is warranted, because the market will effectively police industry and therefore mitigate risk; 3) distrust in GE is due to a marketing failure of the benefit side of the risk-benefit analysis; and 4) as a leader of the free world (and global market economy), the United States is ultimately responsible for global well-being. The Free Market Rules frame was applied in the national and global contexts in the Bt-monarch case, as the ecological risk debate unfolded on both the national and global stages. The important subtext of this frame is that wealth generation is a universal human aspiration, and that free-market capitalism is the most expeditious means to achieve that goal. Reverse discourses that challenge some of these core cultural notions are those of sustainable development and the precautionary principle.

The frame was called to the fore mainly through the global trade disputes that were occurring at the time of the Bt-monarch case, but also through the apparent shortcomings in the U.S. regulatory systems for GEOs. The GEO debate presented challenges to some of the core notions of free market regulation—in particular, the lack of free flow of information, the concentration of power amongst a handful of global seed companies, and the unequal distribution of risks and benefits across social sectors and global communities. As was the case with the Science as Savior cultural frame, a tension was created when the reality of the Bt-monarch situation was contrasted with the core cultural notions of this frame. This tension ultimately helped to maintain the story's newsworthiness throughout the issue cycle, and thus propelled the story forward on the media agenda.

Figure 4.5 ***The Free Market Rules*: Central and Supporting Cultural Notions**



Note: Dark circles are central notions of the cultural frame. Lighter circles are supporting notions that case study cognitive frames present as connectors to the broader cultural notions and frame.

Risk (Cost)-Benefit Analysis. In the U.S. free-market system, risk- (cost-) benefit analysis (RBA) is a well-accepted method for weighing the expected risks/costs of development options against their benefits in an effort to choose the best option. In its more formal econometric practice by government entities, benefits and costs (or risks) are expressed in monetary terms in order to gauge whether or not a given intervention is suitable for all of the stakeholders involved (usually by monetizing preferences through behavioral inference or survey methods). By this definition of RBA, the calculations in the Bt-monarch case would compare the risks/benefits of a future global agriculture system based on GE crops with one based on some alternative agricultural system. The most explicit reference to the RBA notion was found in the *Washington Post* toward the end of the case study coverage:

> Yes, transgenic crops carry risks. The Monarch butterfly is famous because the damage it suffered from modified corn is the closest to a smoking gun the antis have come up with.
>
> But damage to the Monarch has to be weighed against the prospect that fewer forests will be cleared and fewer children will go hungry. It also must be weighed against damage to the Monarch from not embracing biotechnology. The alternative to butterfly-killing corn may be corn sprayed with butterfly-killing pesticides. (*WP* 7/9/01)

In environmental analyses, such calculations are commonly "strained and distorted," according to Kellert (1996), because an "overwhelming bias exists toward activities measurable in dollar terms and associated with well-established human needs" (p. 163). Those species and natural phenomenon without established marketplace values—such as some non-target species, cultural activities or rare habitats—don't fit easily into such analysis, and the "needs of ecosystems" are secondary (Song & M'Gonigle 2001). So was the issue of the Bt-monarch case.

Econometric RBA studies of for Bt crops were not available at the time of the case study. In spite of this, overt references to a cost-benefit analysis of the social worth of GE crops (explicit mentions of weighing risks against benefits) were made 12 times across 10 articles during the case study newspaper coverage. This leading cultural notion was actually recalled in newspaper coverage much more routinely, however, because as discussed above, potential GE crop benefits and ecological risks consistently appeared throughout the coverage. Often, the risks and benefits were outlined in successive paragraphs, likely as part of the journalism practice of "balance." While the industry and other pro-biotechnology interests advocated for weighing the *potential* benefits from the technology against the *perceived* risks, journalists and others recognized that such metrics of the technology's social worth were far from straightforward:

> Ultimately, risks posed by these crops must be weighed against the benefits they offer farmers, consumers and the environment. But even as the first large-scale studies of benefits of genetically modified plants appear, more questions than answers remain. Even for Asgrow's squash, the plant that Mr. Tricoli [research scientist, Seminis Seeds] called "the most highly regulated and reviewed squash product ever produced," the costs and benefits to famers and the environment remain unclear.
>
> In Idalou, [farmer] Mr. Thiel…was philosophical."We've got a long way to go before we know whether [the GE squash is] good or bad," he said. "The way I see it, whenever you get something, you lose something else. We just don't know what we'll lose yet." (*NYT* 11/3/99)

One key problem brought to light by the Bt-monarch case in this regard was how to "value" a non-target species with little or no economic benefit to industrial agriculture:

> One reason so little is known about the magnitude of ecological risks in general is that regulators deemed some effects, including those to

> species like the monarch—which are neither beneficial to agriculture nor legally protected as endangered species—of little concern.
>
> "We knew things like monarchs and other butterflies would be susceptible," Dr. Arnold Foudin, an assistant director of scientific services at the Department of Agriculture, said … "That's part of the general background noise." (*NYT* 12/19/00)

The potential impacts to the monarch, a powerful symbol of the fragility of nature, symbolically underscored a fundamental flaw in a U.S. regulatory approach that devalued those natural resources that didn't present clear economic gains/losses in agro-economic equations. The general public's "emotional" reaction to the potential threats to the species also challenged the notion that cost-benefit analyses were an "objective" and/or "rational" means to evaluate such social worth.

In terms of the cost-benefit equation to U.S. farmers, the biotechnology industry had difficulty making a clear case in favor of GE crops. Farmers were actually loosing money on Bt corn, even as the industry was trying to sell its benefits. At the time of the case study, American farmers were not realizing the financial benefits of Bt corn, which when planted represented a net loss to U.S. farmers of $1.33 per acre, according to Benbrook (2001), largely due to 30-35% higher-than-average seed costs. The pesticide investment for U.S. crops in general was also showing up red on the balance sheets. According to Altieri & Nicholls (2001) an annual investment of about $40 billion in pesticide control (an estimated $1 billion for the ECB) by U.S. farmers saved approximately $16 billion in U.S. crops (numbers that don't include an estimated $8 billion in additional secondary environmental and social costs from pesticides, such as impacts to wildlife and water quality and human poisonings and illness).

The consequence of this negative cost-benefit ratio on the national farming level meant the extrapolation to secondary and tertiary financial implications of the technology by stakeholders and the media. Commonly, the media reported the scale of the U.S. farming industry that might be impacted by rejection of GE crops—a practice already discussed here (p. 132). Other financial extrapolations were also being made, however, heightening the economic anxiety of GE crop rejection. Examples of such could be found in media and supporting documents alike:

> In Europe, the public sentiment against genetically engineered food reached a ground swell so great that the cultivation and sale of such food there has all but stopped…Nearly two-thirds of the products on American supermarket shelves are estimated to contain genetically altered crops….Today's protest, however, may indicate some swelling in the opposition. (*NYT* 3/27/00)

> These products directly benefit growers by reducing costs and boosting yields and indirectly benefit consumers by fostering more environmentally friendly farming practices, including reduced reliance on chemical fertilizers and pesticides. They directly benefit consumers by maintaining stable food supplies, which also help keep prices stable. (BIO 11/16/99)

> Though Glickman expressed strong support for agbiotech, his remarks also reflected his more recent conciliatory stance toward critics. The new strategy comes amid Europe's rejection of engineered crops--resulting in potential losses of hundreds of millions of dollars for U.S. farmers--and fears that U.S. consumer opposition may be growing. (UCS 1999, "USDA announces new biotech policies")

Framed in terms of a cost-benefit ratio, then, it made sense that the biotechnology companies and industry organization did what they could to emphasize the benefits of GE crops—even if they were largely theoretical at the time—to balance the emerging concerns about ecological and food safety/security risks. Chief among the benefits promoted were crops with increased nutritional value and the pre-commercial research being conducted at the time on vitamin-A-enhanced, "golden" rice. Of course, with the industry trying to bolster the risk-benefit balance sheet with potential benefits, it was easy to frame the issue as a public relations failure on the part of industry, rather than a real problem with the GE regulatory or ecological risk assessment frameworks. This problem definition was evoked, as described above, through the Crisis of Confidence cognitive frame (p. 210). To illustrate just how seriously the industry was promoting the Crisis of Confidence interpretation of the problem, consider that between 1992 and 2002 the USDA spent about $1.8 *billion* on biotechnology research and development, while spending approximately $18 *million* on risk-related research (Mellon & Rissler 2003). By comparison, the Council on Biotechnology Information budgeted $50 million for an "information campaign" about the benefits of biotechnology for the 3- to 5-year period following the emergence of the Bt-monarch case (BIO 4/3/00). While the industry was spending millions on GE crop promotion, it was also continuing to advocate for the doctrine of substantial equivalence and limited industry regulation, which was a second central notion of The Free Market Rules cultural frame.

Invisible Hand of Free Market Forces. Part of the reason the risk-benefit analysis holds cultural sway in the United States is a tendency toward *laissez-faire* political economic philosophy, which extols the benefits of private property ownership and seeks to minimize government regulation and intervention across all aspects of social life (Stewart & Bennett 1991). In the United States, capitalist nations are viewed as the primary drivers of global economic growth, and the assumed higher standard of living that comes along with it. A core notion in U.S. culture is that when individuals promote their own self interest, Adam Smith's (1776) "invisible hand" of free market mechanisms will control production, prices and the allocation of resources to the mutual benefit of market participants ("By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."). In the end, society as a whole is better, according to this notion, because individuals seek to increase their happiness through the accumulation of wealth, a circumstance that can only be attained through keen awareness of what other people desire (i.e., responding to market demands). Of course, this notion rests on three key assumptions: 1) strong individual property rights; 2) strict adherence to social norms (e.g., dishonesty and theft must be avoided); and 3) good access to information about products and services.

In the Bt-monarch case, the implicit notion that supports this cultural frame is that the "invisible hand" of free market mechanisms can also effectively mitigate *risk* from GE crops to humans and the environment. Market incentives (e.g., consumer demand) will encourage the development of only those GE crops that are of acceptable “risk” to human health and the environment. If consumers perceive risk to themselves from GE crops (either directly through the safety of the foods they are consuming, or indirectly through water degraded by pesticides), they will not purchase the products offered. Likewise, farmers acting in their own self interest will not purchase seed varieties that negatively impact their bottom line financially (either directly because the increased seed costs make them unprofitable, or indirectly because alternatives will negatively impact farm operations—like increases in pest populations).

Rational choice is the market mechanism that asserts that social patterns of behavior will reflect the rational choices of individuals (e.g., comparing the risks and benefits of selecting different seeds or foods for purchase) (Scott 2000). Rational choice is based on two assumptions that may or may not hold in the Bt-monarch case: 1) individuals have full information about the consequences of selecting each of the options available, and 2) individuals have the means to make such a choice (e.g., ability and opportunity). The first assumes that if consumers know of the potential ecological risks to monarchs from Bt crops, they will modify their purchasing decisions based on their concern (or lack thereof) for the species. In practical terms, it’s difficult to imagine that many individuals would view monarch survival as promoting one’s own self-interest (ala Smith’s invisible hand), unless he/she perceives the self within the “fragility of nature” symbology, which in an urbanized world is increasingly unlikely. As Song & M’Gonigle (2001) point out

> Economic growth has led to the increasing centralization of power in big institutions, from larger corporations to mega-cities…profound sociological effects accompany the removal of human institutions from a natural environment, where the ecological effects of individualism are not easily perceived. (p. 983)

The second assumes that consumers can differentiate between choices on supermarket shelves. This is also problematic, given current U.S. labeling policy for GE ingredients. Indeed, media coverage emphasized the U.S. public's lack of both knowledge about GE crops (e.g., "most of them don't have a clue" *NYT* 9/8/99) and ability to do anything about them (e.g., "one hot question is whether farmers actually have much choice [to choose GE or non-GE seeds]" *NYT* 12/20/99).

In spite of these rather obvious tensions with the cultural frame in this case, the emphasis on rationality and the reducibility of social phenomenon (e.g., consumer choice) to individual action appeals to The Free Market Rules cultural bias. This is especially the case for an industry seeking to sponsor a Crisis of Confidence cognitive frame—defining the Bt-monarch problem as a marketing failure rather than as a legitimate ecological concern. Thus, rational choice theory became the *basis* of the biotechnology industry's opposition to product labeling for GE ingredients. Rather than allowing consumers to make a rational choice *not* to purchase products with GE ingredients, however, industry argued that they ought to instead make the choice in favor of "traditional or specialty foods" if they so desired:

> Labeling policy…is unnecessary, because competitive markets will give consumers the products they want and the information they need to find them. Consumers who desire to purchase traditional or

> specialty foods create opportunities for companies eager and able to serve them. Consumers today may choose from a bounty of "organic", "natural", or "kosher" offerings. Manufacturers voluntarily identify and actively promote goods that meet these and other descriptions. (BIO 11/18/99)

Importantly, this framing again positions GE crops in a normative frame, and traditionally bred and organic crops in the "other" frame (delegitimized). The position is also supportive of the viewpoint that GE is the "inevitable" future of global agriculture. In a culture biased by the notion of "rational choice," the "emotionalism" with which European nations and "anti-biotechnology" protesters were apparently making decisions about GE regulations was particularly irksome, and hence delegitimized. The rational choice bias may be one explanation for why the "Description of Public Sentiment" and "Characterization of Research Findings" sub-nodes were so prominently featured in the Descriptors and Labels node for newspaper articles written about the Bt-monarch case. U.S. culture values science (and its interpretation) as a rational approach to reach decisions about major policy issues, as well as individual choices. There is explicit recognition in the media coverage of the important link between public sentiments (and the role scientific debate plays in influencing that sentiment) about GE crops and their ultimate success or failure in the market economy (see p. 102).

The tension created within The Free Market Rules frame by this notion of rational choice in the timeframe of the Bt-monarch case came when, in the face of some obvious risks (both to the environment—ala monarch larvae and gene introgression in Oaxaca—and to the human food supply—ala Starlink) it became clear that consumers really didn't have the *ability* to make a choice. Psychometric risk assessment research has long understood that a person's perception of individual risk increases when he/she doesn't perceive personal control over the risk situation (Krimsky 1992, Slovic 1992). Further, contemporary psychometric risk research also recognizes that risk is *inherently subjective*, and that non-scientists have their own internal risk models, which are "influenced by a wide array of psychological, social, institutional and cultural factors" (Slovic 1992, p. 119-120). In short, the rational choice theory of market behavior is problematic when risk is perceived. While pro-biotechnology interests were quick to dismiss opposition to GE crops as "emotionalism," the reality of individual risk perception and its influence on an individual's decision process is more complicated. Implications of this individualistic perspective and its influence on wider social phenomenon and the market economy are now the subject of popular literature (e.g., Gladwell 2005; Thaler & Sunstein 2008). The important point here is that U.S. cultural faith in the invisible hand of rational choice can only work 1) if an actual choice is available, and 2) if individuals will actually make purchasing decisions based on their knowledge of the consequences of these choices. Neither of these conditions could be met under then-U.S. regulatory policy. Further, in the case of *ecological* damage, it's unclear whether knowledge of such consequences actually influences the choices made by farmers or consumers.

Threats to Innovation from Regulation. Another element of the invisible hand that came into play in the Bt-monarch case was the notion that *market incentives* encourage innovation of new technologies to meet environmental challenges. Since it is widely assumed that innovation also fuels global economic growth, crop biotechnology was an apparent win-win scenario for proponents of *laissez-faire* free-market philosophy. Privatizing GE products through patent protections was one way to incentivize further GE crop development (*WP* 7/11/00). *Lack of* clear market incentives served as justification for the industry to pursue only those GE crops that would be readily profitable to biotech companies ("it's not fair to look to the private sector to solve problem of international assistance" *WP* 7/11/00). Even proponents of sustainable agriculture concede this cultural frame bias, remarking that crop rotation strategies likely won't be pursued on a global scale because, "it involves processes and not products, there is no industrial constituency to develop and support crop rotation as there is for the products of biotechnology," (UCS 2000, "Alternatives to genetic engineering").

In order to maximize the potential of this win-win scenario for the environment and global agriculture, The Free Market Rules frame encouraged *minimizing disincentives* to biotechnology development. Strong regulation is perceived as a major disincentive. Encouraging further GE innovation through minimal regulation was the primary free market incentive referenced in The Free Market Rules frame. Industry and regulators alike view the ecological risks of GE as *controllable* rather than *avoidable* (e.g., "With proper testing and regulation, biotechnology products are safe, [proponents] contend, adding that the world has no choice but to adopt them," *WP* 1/24/00; "But industry and government officials say the risks can be controlled," *WP* 5/30/01). According to Zavestoski et al. (2004) the drive to accumulate wealth results in collusion amongst government and industry to enact policies that are conducive to the accumulation of private wealth,

> Under pressure to maintain a regulatory atmosphere conducive to economic growth, the strategy of many agency officials has been to downplay risks that may be expensive to remediate…Institutional framing of risk serves as another cog in the machine powering the treadmill of production, ensuring public policies with respect to the toxic by-products of the treadmill do not threaten the treadmill itself. (p. 259)

The chief argument made by the pro-biotechnology companies was that GE crops were the most-studied and highly regulated in the history of modern agriculture, and therefore didn't need additional regulation, oversight or research effort devoted to them. Absence of evidence of ecological harm was often promoted as evidence of safety (e.g., concluding that one study confirmed that biotech crops "pose no adverse health or environmental problems," *NYT* 9/26/00). One BIO news release may even have lead readers to believe that every biotechnology crop was reviewed by three regulatory agencies before widely planted:

> …biotechnology crops planted in the United States and the foods derived from them have gone through thorough environmental and food safety reviews by U.S. regulatory agencies before commercialization, including the Food and Drug Administration, the U.S. Department of Agriculture and the Environmental Protection Agency. They have been more rigorously scrutinized than any other foods in history, and shown to be safe. (BIO 11/24/99)

Of course, in practice the three agencies actually divide this responsibility depending on how the crop is modified and which traits are novel to the GEO (i.e., the regulatory protections are not additive with three agencies). The doctrine of substantial equivalence meant that these crops were little tested for ecological risks in the field prior to commercialization, a fact that was ill described in media accounts. And, at the time of the Bt-monarch case, the regulatory agencies had still not provided a much-promised guidance document to help GE crop developers decide when the agricultural products they were engineering might require additional ecological field testing prior to commercialization (*WP* 8/15/99). Yet, regulators and the industry were eager to instill trust in the regulatory system and maintain the status quo. To do so, examples from the 1990s—like stopping a potential deadly GE soybean (engineered with a highly-allergenic Brazil nut protein to "bolster nutritional value") from coming to market and the market failure of the Flavr Savr tomato (which lab rats wouldn't eat, but were deemed "safe" for human consumption)—where held up as examples of how well the U.S. regulatory system and market forces worked to mitigate risk (*WP* 8/15/99).

Thus, when it became clear that one variety of Bt corn was significantly more toxic to monarch and other non-target larvae (Event 176) than the others, the market was also implicitly credited with keeping that form from becoming widespread in its use, even though the regulatory system had failed to prevent it from coming to market in the first place (emphasis added):

> …*companies are phasing out* Bt corn varieties that produce a particularly toxic pollen—those that carry the genetically engineered DNA known as Event 176. The change could help reduce risks to monarchs and other nonpest insects (*NYT* 9/26/00)
>
> An adverse effect on caterpillars was seen at a lower dose with one rarely planted Bt corn: Event 176…But event 176 was the earliest developed Bt corn and *was quickly supplanted by other types*. It has *never been planted on more than two percent* of all the acres planted with corn...(USDA 2002, "Butterflies and Bt corn")
>
> This particular type of corn *never gained a significant market share* because the Bt toxin isn't expressed well in the corn stalk and as a result isn't particularly effective, Hellmich notes. (Pew 2002)

This notion of market-based risk mitigation was challenged by some, however, who suggested that it was not market forces, or a strong regulatory system that saved the monarch from Bt toxicity risk, but luck (emphasis added):

> The major conclusion of the research was that only one of several Bt-corn varieties (Event 176) approved and planted for use in the United States produced high enough levels of Bt toxin in pollen to be lethal to butterfly larvae. *Fortunately, that variety of genetically modified corn did not sell well and was not widely planted.* Pollen from the two types of Bt corn which account for most of the Bt-corn acreage (Mon 810 and Bt 11) produce relatively low amounts of toxin and pose negligible risk to monarchs. *Had Event 176 turned out to be popular, however, monarchs could have been in serious jeopardy. It was just a lucky break—not government vigilance—that protected the monarch butterfly.* (Mellon & Rissler 2003)

As was described elsewhere in this analysis, within the newspaper coverage was an undercurrent questioning the level of regulation already overseeing GE crops (p. 216). Mentions of moratoria or other such "draconian" (*WP* 1/24/00) regulatory measures were outnumbered by suggestions that the public's confidence in the current regulatory system simply needed to be strengthened with "serious science."

Some would later hold up the Bt-monarch risk assessment research as a model for future ecological risk assessment for non-target species (Pew 2002)—which it probably was, if such assessment were to be conducted *prior to* commercialization and widespread market adoption. The important distinction here is not to confuse pre-commercialization market forces with after-market forces in terms of their effectiveness in risk mitigation. Pre-market forces encourage cost-effective research and development with minimal time to market (i.e., minimal regulation); after-market forces—supply and demand—are reactive and possibly too late for ecosystem protections.

One Big Global Family. Finally, the entire free market mechanisms notion within this frame takes on a larger global perspective when juxtaposed with The Butterfly Effect cognitive frame. The Bt-monarch case came to light in the midst of the global "gene race" and the hype surrounding the mapping of the human genome (Tammpuu 2004). This global competition on the "gene market" encouraged companies to be first to market (and to patent) new GEOs in the biomedical and agricultural fields. Opportunities (i.e., the "benefits" side of RBA) were thus framed as global in their nature (e.g., "feed the world"; the "global marketplace"); risks, on the other hand, are framed as local (e.g., monarchs in Midwestern corn fields; individual choices in the supermarket; potential weed control problems for individual farmers in cornfields). For example, when describing the problem of superweeds, the newspaper articles oftentimes would describe how they might be "costly to remove" or "difficult to eradicate" for farmers (*NYT* 11/3/99, *NYT* 11/12/99). In contrast with the sweeping global humanitarian benefits touted for GE crop benefits, even when the risk of a superweed was presented as a landscape-level issue, geographic descriptors were placed on those issues, rhetorically limiting the "reach" of the risk,

> From the start, scientists were worried about the possibility that the [GE] squash could breed with wild squash, creating a 'superweed' that would proliferate in the wild or farmers' fields, comparable to relentless invaders like the kudzu vine of the South and the zebra mussels of the Great Lakes. (*NYT* 11/3/99)

The upshot of the global benefit–local risk notion is that the world as a whole stands to benefit, while the ecological risks are limited or regional in scope. From an RBA perspective, the benefits outweigh the risks. Note also that the rhetorics surrounding superweeds also assume that *management* and *eradication* of superweeds is possible (if not more costly), which is a conclusion some systems-oriented scientists (and certainly invasive species specialists) question (*NYT* 11/19/99; Regal 1993).

A notable exception to this general "localized risk" presentation was the acknowledgement in one article that weediness may not be noticed for many years after a GE crop's arrival, "making reliable predictions of the long-term likelihood of threats like superweeds extremely difficult" (*NYT* 12/19/00). Here the presentation excluded any geographic locality, but the message is clear that the impact and extent of this potential ecological risk is unknown—and perhaps unknowable—to science.

Even as USDA Secretary Dan Glickman warned GE crop development companies that they must "accept responsibility for environmentally safe products and disclosure of any problems" (*NYT* 7/14/99), the race to commercialize new products and successfully compete in the global agribusiness market had companies and the industry organization commonly defining regulations as "restrictions" instead of the less-pejorative "protections," and calling proposed requirements for refuges as "burdensome" and labeling requirements "unfair" (*NYT* 8/16/99, *WP* 5/30/01). In the competitive environment of the global marketplace, such regulations and the suggestion that companies ought to be liable for any environmental damages their products might cause were unacceptable (Bouchie 2002).

Also unacceptable were potential limitations on free global trade in agricultural GEOs. Countries that were banning the import of GE crops were reportedly participating in unfair trade practices and placing American farmers in financial peril for rejecting the products (e.g., "Several varieties of genetically modified corn have been rejected by European consumers…costing U.S. farmers more than $200 million…" *WP* 1/16/00). The situation left some international trade regulators calling for retaliatory tariffs, like those imposed against European nations refusing imports of hormone-treated beef (*NYT* 8/23/99). And, the agreement that was reached with the Cartagena protocol, in the view of the industry, ought to be subject first and foremost to conditions of the World Trade Organization, which stipulates that "member countries cannot legally refuse imported crops unless they are scientifically proven to be hazardous" (Bouchie 2002).

> The United States and a handful of other countries that pioneered the genetically modified organisms (GMOs) will press for relatively loose control of the trade. Countries that fear their farmers will lose out by not producing such high-yield crops will seek stronger standards…The questions are so contentious that a gathering on the issue in Cartagena, Colombia, last year ended in disarray, with the United States and its allies arrayed against most of the world. (*WP* 1/24/00)

> Last year the world's governments adopted a U.N. protocol on biosafety. More than 100 countries have signed on, and the ratification process is beginning. The protocol says countries (read: paranoid rich countries) can bar some agricultural imports if they fear their biotech content—even if these fears are founded on a 'lack of scientific certainty.' Nobody quite knows whether this provision will be trumped by the World Trade Organization's rules. But the mere possibility that transgenic crops may cause exclusions from rich markets dissuades many developing countries from adopting them. (*WP* 7/9/01)

A magnanimous interpretation of this leading cultural notion would present the framing of this global trade attitude as one in which the United States displays leadership in a global fight to cure disease and end global hunger. This interpretation suggests that by leading nations around the globe into a pioneering GE agricultural paradigm that promises to improve human health and to protect the environment, the United States is acting as a global humanitarian and true leader of the free market global economy. Indeed, that is the interpretation sponsored by the biotechnology companies and industry organization with the feed-the-world rhetorics of the Super Science-Super Problem cognitive frame (discussed above p. 200). It is also the position that was being advanced by free market / limited government proponents from the Competitive Enterprise Institute, a Washington D.C.-based think tank opposed to many forms of environmental regulation:

> … mankind's ingenuity has already provided us an indication of how this can be done. The solution is to ensure that we further liberalize the forces of institutional and technological change that have done so much over the last several centuries to enhance agricultural productivity. Biotechnology is certainly the most promising of these changes. Widespread use of the technologies for recombining plant DNA can help farmers feed the World's growing population, and provide substantial environmental benefits as well." (Conko & Smith 1999, p. 150)

In this interpretation, as the leading global exporter of agricultural products, the United States is positioned as a global patriarch that provides for all of humankind's needs, health and welfare (Tammpuu 2004 found similarly nationalistic identity frames in media coverage of the Estonian Genome Project). This notion is supported rhetorically in the case study articles with the references to how the U.S. biotechnology industry is a leader in GE crop developments that will "feed the world." As a country, the notion goes, the United States is the more "rational" of nations across the globe, and must use its advanced science to calm the fears of those less rational or provincial in their view of GE foods (i.e., European Union and "developing" nations). Positioned thusly, continuation of this grand global humanitarian campaign (designed, developed and implemented by United States) is threatened by such small-minded thinkers who might spread their irrationality to others (ala The Butterfly Effect):

> Kucinich and like thinkers suppose that poor countries should rediscover traditional culture and eschew inappropriate Western technologies. But a report from the U.N. Development Program, to be published tomorrow, blows a hole in this conceit. The threat to development is not inappropriate technology but a lack of technology—medicines, Internet hookups, biotechnology. It's one thing for affluent consumers to eschew transgenic foods. It's another

> for the affluent to impose their choices on poor people. China has shown that genetically modified rice can boost yields by 15 percent in the Third World. But Greenpeace pressures developing countries not to follow China's lead. When Kenya faced famine last year, the antis urged the Kenyan government to refuse U.S. food aid because some of it was genetically modified. (*WP* 7/9/01)

Of course, the prominence of battle/conflict rhetorics in the media articles also communicates a less-altruistic interpretation of the U.S. dedication to the notion of The Free Market Rules frame, one that suggests an inclination toward extending U.S. cultural dominance, or hegemony, across the globe. Such hegemony is marked by attempts to extend U.S. social, ideological and economic influence to other parts of the globe through coercion of cultural institutions such as the mass media, educational curricula or popular entertainment. In these terms, agricultural biotechnology represented for some, the extension of American values into the traditional cultures through the very food that they ate. For example, Shiva (1992), Brush (2004) and others have suggested that crop biotechnology has been disruptive to traditional societies, and that industrial agriculture has fostered greater biodiversity loss, rather than promoting its conservation. At the time of the Bt-monarch case, there was a great deal of discussion about how use of the so-called "terminator" gene (which renders the seed and crop it produces sterile) would force southern hemisphere farmers to re-purchase seeds every season, essentially "slipping a noose around the neck of poor farmers" (Mann 1999, p. 38; also see Priest 2001).

Certainly discussion of punitive trade tariffs supported such an interpretation, as did references to removing the existing environmental protections in GE crop development (e.g., "that requires that the anti-technology policies promoted by our modern Malthusians be defeated," Conko & Smith 1999, p. 153). The notion of cultural hegemony was also evoked with references to the continued global consolidation of seed companies, which by the time of this case study were already frequently large global conglomerates with economic interests in a variety of food, health and agricultural products that extended deeply into many aspects of cultural life. The "coercive" discursive construction that undermined the explication of this notion of U.S. free market hegemony, of course, was the assertion that GE was merely the next logical paradigm for agricultural advancement, rather than, say, a radical new approach to domination of the natural world. The suggestion of such social, cultural and macro-economic hegemony rankled at least one biotech company executive (in this light, note the reference to putting the "old order to rest"):

> "People say we're playing God," said Daniel Vasella, president of Novartis, the Swiss pharmaceutical and biotech giant that owns Gerber. "But that's what they say about Icarus and flying or Prometheus and fire or Galileo. You put the old order to rest, and you're told you've questioned the rule of God and you will now be punished like the fall of the Tower of Babel." (*NYT* 3/14/00)

First, Do No Harm: A Reverse Discourse. The obvious challenge to The Free Market Rules cultural frame came from emergent notions of sustainable development and the precautionary principle. ("Emergent" is a relative term, of course, applied here in terms of U.S. culture. These notions have enjoyed longer-standing relevance in other parts of the world.) The most widely accepted definition of sustainable development holds that rather than blind devotion to economic growth, development ought to instead seek a steady state global economy that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987; UN 1992). Because of the fuzziness of the concept, an inherent tension exists in the "triple bottom line" of sustainable development (economic prosperity, environmental quality and social equity) due to the alternative interpretations of its definition—on the one hand anthropocentric; on the other, ecocentric. Advances in technology are typically viewed as the primary means to attain sustainable development, and biotechnology was cited in Agenda 21 as a primary means to improve global agriculture while protecting the natural world. If one views sustainable development from a more anthropocentric standpoint, the RBA view of The Free Market Rules frame likely makes a lot of sense. However, if one comes at sustainable development from a more ecocentric standpoint (as many ecologists or systems scientists do), RBA and the "invisible hand" market dynamics are problematic in the face of ecological risk (see Daly 2009; Orr 2009). Hence, the reverse discourse of "the precautionary principle" emerged in relation to the Bt-monarch case, and was based on two core cultural notions: 1) society would wait for reasonable evidence that GE crops would not cause harm to human health or the natural world before commercializing the GE products; and 2) the burden of reasonable proof of safety, as well as liability for damage, would lie with the developer (Raffensperger & Tickner 1999). According to Principle 15 of the Rio Declaration,

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UN 1992)

The precautionary perspective reframed risk evaluation of GE crops from *assessment* ("assessing and managing an assumed industrial activity") back toward *reduction* ("redesigning the industrial process to reduce the generation of uncertainty, including restructuring the activity itself") (Song & M'Gonigle 2001, p. 984-985). Thus, the precautionary (or, "risk reduction") counter-discourse encouraged a critical re-evaluation of leading cultural notions that presumed continuous economic growth through technological advancement, permissive "free-market" regulation of industry, and ultimately an unencumbered continuation of intensive industrial agriculture. Counter to the pro-biotechnology critique of the precautionary approach as "backward," Song & M'Gonigle argue that such a perspective is actually highly sophisticated, encouraging "innovative-based management by preventative design" that would "avoid creating surprises by shifting to selective production technologies (e.g., ecoforestry), by closing the production loop (e.g., recycling rather than disposal), or by embracing more 'natural' techniques (e.g., biodynamic rather than industrial agriculture)" (p. 984-985).

As described above (p. 199), the actual term or regulatory philosophy behind the "precautionary principle" was little discussed in the U.S. newspaper coverage of the Bt-monarch case, but was nonetheless being advanced elsewhere within the

United States and across the globe. For example, the World Wildlife Fund (WWF) was calling for a global moratorium on commercial use of GE crops until governments had conducted comprehensive risk assessments, and UCS was calling for increased research and oversight in the early development phase for new GE crops, especially for the then-emerging "stacked trait" crops (e.g., UCS 1999, "Forests at risk"; UCS 2000, "Biotechnology policy"). In some of its communications, UCS was actually appealing to the "crisis of confidence" and "PR problem" notions sponsored by industry by making the case that a more precautionary approach would ultimately increase the public's confidence in GE crops (e.g., UCS 2002, "To USDA").

The UCS stopped short, however, of actually advocating directly for the application of the "precautionary principle" in the U.S. governance of GEOs, and more-or-less conceived of the precautionary principle in terms of advocacy for a prescriptive research approach to comprehensively evaluate ecological risk. The term "precautionary principle" was never actually referenced in UCS documents examined here. By contrast, the Greenpeace documents examined referenced the "precautionary principle" or "approach" frequently in the organization's communications about GE crops (16 passages were found in the supporting triangulation documents). The organization is clear that it believes precaution ought to guide all future exploration into GE crops, and even makes one very forthright statement about the need to look beyond risk *assessment* when food safety is concerned:

> Greenpeace is calling for precaution to be the basis of all decisions on GMOs since the long term effects of this new technology are mostly unknown and what is known causes concern. Any government should have a right to stop any import of GMOs if it suspects there may be environmental or health risks. (Greenpeace 9/15/99)

> The Precautionary Principle must be the basis for assessing the human health effects of GM food. Where human health and safety are concerned, mere "risk assessment" is not acceptable. (Greenpeace 12/7/00)

Based on U.S. newspaper reportage of how the precautionary principle was being advanced in Western Europe, one might expect that the triangulation documents from European newspapers would have been flush with discussion of the precautionary principle. This was not the case, however. In fact, like the U.S. newspapers, the European newspaper articles examined here never mentioned the concept by name. The difference in the European approach to ecological risk assessment was clear, however, even if it wasn't called out by name. And the European newspapers used the Bt-monarch case as a rationale for moving more methodically in approving GE crops for commercial planting in the European Union:

> [The Bt-monarch case] showed up a giant gap in the US research programme: that the wider environmental impacts of growing GM crops had not been properly investigated, despite the fact that nearly half of all staple crops are now GM… This omission has cost the industry and the administration dear, not least because it has given the UK a copper-bottomed excuse to hold up the introduction of GM crops, until the effect on the wider British environment can be studied. (*The Guardian London* 8/9/00)

In the few U.S. newspaper accounts where the precautionary approach was addressed, it was in reference to a regulatory philosophy that was predominant *outside of* the United States—either in Europe or amongst developing countries of the southern hemisphere. If not coming from the outside, the principle was delegitimized as one that was held by "private activist groups" (*WP* 1/24/00). When references were made to moving more slowly on GE crop commercialization until ecological risk research could "catch up" to the technology, the philosophy was typically described as circulating amongst university research scientists or the UCS. Only once was the notion of caution attributed to a government source—Dan Glickman (*NYT* 7/14/99).

Of course, the precautionary principle concept met with staunch opposition from free-market advocates, claiming for example that the principle sought to "stop innovation before it happens":

> Anything new is guilty until proven innocent. It's like demanding that a newborn baby prove that it will never grow up to be a serial killer, or even just a schoolyard bully, before the baby is allowed to leave the hospital. Under this corollary, inventors, scientists, and manufacturers would have to prove that their creations wouldn't cause harm--ever--to the environment or human health before they would be allowed to offer them to the public. (Bailey 1999)

Such all-or-nothing characterizations of the precautionary principle were, of course, gross misrepresentations of what the principle was actually advocating, which was ultimately self-determination for governments that were unconvinced by the research evidence then available that GE crops were "safe" for human consumption and the environment. Characterizations of such ridiculous demands of "proof of safety" also undermined the legitimacy of the principle. While it is true that there were some organizations and governments calling for GE crop moratoria until more comprehensive ecological risk assessments could be conducted, few were actually demanding *absolute proof* of the crops' safety. However, such calls for more complete ecological risk information were a threat to The Free Market Rules cultural frame, which richly rewards those companies that are "first to market" GE crops for global distribution. In this light, precaution was portrayed as "protectionism" by European countries perceived to be less advanced in GE crop development (*WP* 1/24/00).

Today, in a period of economic downturn the reverse discourse of precaution may be even more challenging to advance than it was in 1999-2001, especially when science is being looked at not only as a means toward human progress and advancement, but also as economic stimulus. A recent article in *Science* paints the scene in The Free Market Rules and Science as Savior cultural frames nicely:

> The main character: a young president who has promised to "restore science to its rightful place." The supporting cast: a Congress dominated by Democrats heeding President Barack Obama's call not only to "create new jobs but to lay a new foundation for growth." This week, those elements culminated in a historic $787 billion economic stimulus package that provides more than $21 billion for research and scientific infrastructure. (Kintisch 2009)

With a renewed emphasis on human stem-cell research ushered in under the Obama administration, there is little doubt that crop biotechnology will also benefit from this infusion of federal monies into research and infrastructure. Only time will tell if the promises of sustainability by the new administration—and the attendant emphasis on systems-level sciences, risk research and cost/risk-benefit analyses that meaningfully incorporate externalities—will benefit as well.

Elucidating a Descriptive Model for Framing Ecological Risk

Philosopher Immanuel Kant argued that concepts (theory) without percepts (observations) are empty, and that percepts without concepts are blind (Krimsky 1992). Risk science without examination of the social construction of risk—in both conceptual and perceptual forms—misses an opportunity to understand the complex dynamics at play with public acceptance or refusal of new technologies. This chapter, therefore, concludes with an examination of where this research fits into the theoretical frameworks of social risk literature and makes a case for the importance of such study in the endeavor of conserving biodiversity.

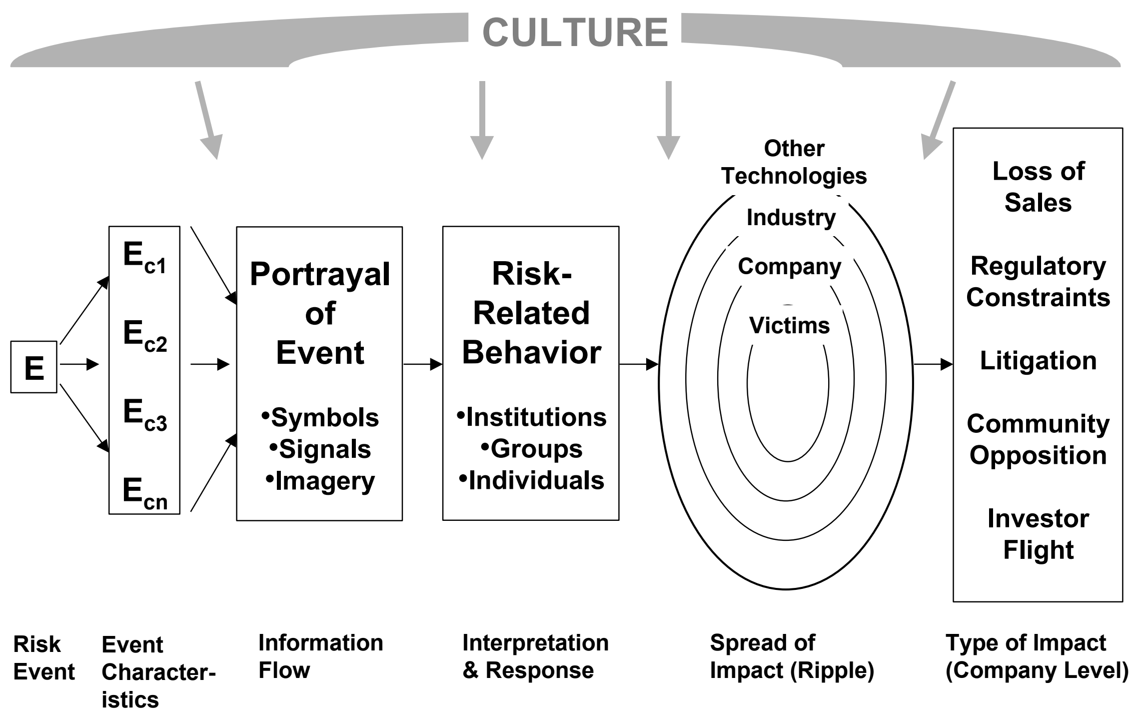
The field of conservation biology has long recognized the need to incorporate the "human factors" of the conservation equation. However, many systems-level scientists, ecologists and conservation biologists, may overlook how the social construction of ecological risk might influence and inform their decisions about how to present their science to lay audiences. As O'Riordan and Rayner (1990) point out, knowledge about science typically moves along well-established pathways that tend to strip away, or even ignore, essential interconnections. These pathways, or accepted modes of scientific inquiry and reporting, thereby "unavoidably distort the character of the phenomenon under study" (as cited in Kasperson 1992, p. 157). Thus, understanding risk amplification and attenuation via mass media channels might help practitioners better position their science in socially and culturally informed ways.

Broadly, social theories of risk fall into two predominant paradigms, positivistic and constructivist (Rosa 1998). Positivistic approaches include the traditional technical risk assessments paired with the development of social risk indices (Fischhoff, Watson & Hope 1984). More richly explored are the constructivist approaches, which now include cultural studies of risk (Douglas 1992; Rayner 1992), psychometric research approaches (Slovic 1992), arena theory explorations of socio-political actors (Renn 1992) and the social amplification model of mediated risk amplification and attenuation (Kasperson et al. 1988; Kasperson 1992). Although critiqued in the same issue in which it was originally published (Rappaport 1988), Kasperson et al. (1988) outlined a comprehensive research approach for addressing the social dimensions of risk assessment with a model based on communication theory (Figure 4.6). The model was premised on the notion that "social structures and processes of risk experience, the resulting repercussions on individual and group perceptions, and the effects of these responses on community, society and economy" interact with the basic technical risk equation to socially construct risk (p. 179).

Since much of perceived risk does not happen through direct experience, but rather through communication or reporting of an experience, this model seeks to broadly conceptualize and analyze how information flows and affects the perception of risk. It therefore aims to address how messages are constructed, encoded, transferred, decoded, interpreted, responded to, spread (the "ripple effect"), and ultimately how they impact societal construction of risk as a whole. Kasperson et al. (1988) lump these processes into two broad categories: 1) the *informational mechanisms* (the left-hand elements of the model) and 2) the *response mechanisms* of social amplification (right-hand side of the model—from risk behaviors, ripple effects and consequences).

The informational mechanisms described by Kasperson & Kasperson (1996) include volume (quantity of media coverage), the degree of informational dispute (how much the facts are disputed), dramatization (reporting of incorrect facts, rumor), and symbolic connotations (addressing the different concepts of social and cultural groups). The response mechanisms address the social, institutional, and cultural contexts in which risk information is interpreted, diagnosed and valued, and may include 1) heuristics and values, 2) social group relationships, 3) signal value, and 4) stigmatization. Via these response mechanisms, according to Kasperson et al. (1988), the impacts of perceived risk can either trigger or hinder positive changes for risk reduction. Largely a descriptive model of overall risk, Kasperson (1992) has long argued for case studies to fill in and flesh out the elements of this basic descriptive model for the social construction of risk. McInerney, Bird & Nucci (2004) described in broad terms how media coverage of the Bt-monarch case may have impacted the *response mechanisms* of Kasperson's model, focusing the ripple effects of media coverage on GE policy formulation.

Figure 4.6: Social Amplification & Attenuation of Risk



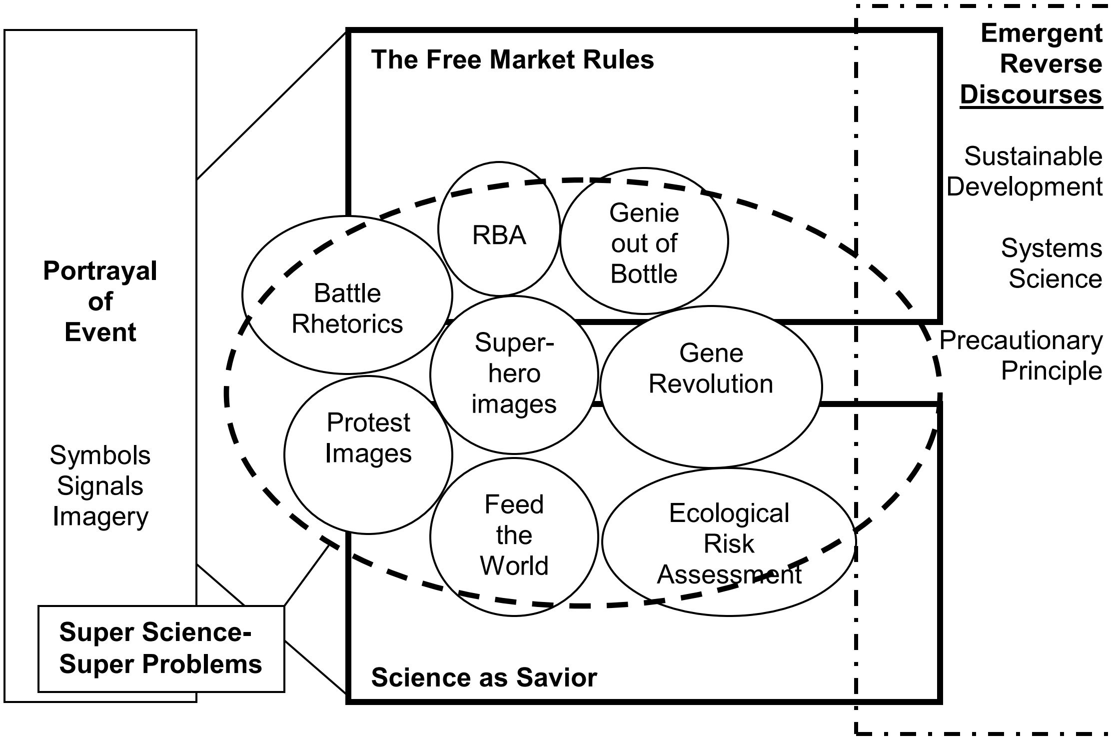
Source: Kasperson (1992).

Note: Kasperson titles this visual representation of the model, "Highly Simplified Representation of the Social Amplification of Risk and Potential Impacts on a Corporation," in his 1992 publication. The original, 1988, representation of the model is more detailed; however, Kasperson et al. did not developed the informational mechanisms aspect ("inputs") of this model in either rendition.

A frame-based research exploration of media messages about risk, as demonstrated by the current research, also offers a promising approach to better describe the *information mechanisms* at the front end of Kasperson's model. In particular, parsing the cognitive and cultural frames at play during a risk event (and their sponsorship) offers a bridging method between risk communication theory and the cultural and social arena theories of risk described by Douglas (1992), Rayner (1992) and Renn (1992). Because how risks are framed in the media impacts how risks are amplified or attenuated by the general public, some cognitive frames, if successfully placed (or sponsored), may evoke cultural frames that have strong emotive or persuasive power in the social milieu. Explicating how immediate cognitive frames evoke broader cultural frames essentially engages the amorphous "culture" element floating above Kasperson's model in a more meaningful way. If the research method also explores the *sponsorship* of such immediate cognitive frames (which the present research only accomplished superficially), the model also has explicating power for how social regimes (institutions, relationships and social interactions), as well as social actors and stakeholders, influence the information side of risk construction (ala Douglas 1992, Rayner 1992, and Renn 1992).

For example, the placement and sponsorship of the "Super Science—Super Problem" cognitive frame is illustrative in this regard, because it triggered elements of the broader cultural frames "Science as Savior" and "The Free Market Rules." American media—as represented by the *New York Times* and *Washington Post*—framed the Bt-monarch case according to a cognitive frame that was broadly accepted—that the science of crop GE was the only way to feed the world while also saving the environment. Rational science was also capable of ecological risk assessments that could identify and mitigate the potential risks that might emerge as a result of broad use of this new technology. The challenge to the Super Science side of this frame was the dialectic Super Problem notion, resolved through the free market practice of risk- (cost-) benefit analysis on a grand global scale. The interplay of the cognitive with the cultural, presented thusly, is not as linear as the Kasperson model intimates, however, suggesting a much more reflexive interaction between the two kinds of frames, the risk event's characteristics (and how they are described), and the risk-related behaviors (interpretation and response) that emerge as a result of the mediated information mechanisms (Figure 4.7). The elucidation of the information mechanism in Kasperson's model through frame research also has the potential to explicate how reverse discourses might also influence the mediated construction of risk—challenging existing cognitive and cultural frames, as well as potentially reshaping them over time. In the Bt-monarch case, The Free Market Rules and Science as Savior frames were challenged by emergent reverse discourses related to sustainability, systems approaches to the natural sciences, and an alternative regulatory approach (the precautionary principle).

Figure 4.7: Mediated Information Mechanisms in Risk Construction



Note: This example illustrates how the Super Science—Super Problem cognitive frame interacts with the broader cultural frames of The Free Market Rules and Science as Savior. The use of a frame-based research approach has potential to elucidate the interaction of culture with the mediated information mechanism in Kasperson's Social Amplification/ Attenuation Model of Risk. Circles represent document nodes from media articles; the oval represents the immediate Super Science—Super Problems cognitive frame; rectangles represent The Free Market Rules and Science as Savior cultural frames, as well as emergent reverse discourses that challenge those frames.

Further research focused on frame sponsorship could help describe the institutional frameworks and social networks that impact the information mechanism in the social risk construction. While such analysis is beyond the scope of this research, exploration of triangulation documents here suggests, for example, that the biotechnology industry may have been an influential sponsor of the Super-Science aspect of the Super Science—Super Problem cognitive frame through its persistent promotion of crop GE as the inevitable pathway toward a technology-enabled agricultural "sustainability."

This research reinforces the importance of gaining a deeper understanding of the mediated information mechanism that is so influential in the social construction of risk. Such understanding is necessary if conservation practitioners hope to evolve the *reverse discourses* of sustainability and systems thinking into *dominant cultural frames*. The rapid development of agricultural GE, without ecological systems in mind, threatens biodiversity in ways that are still not well studied or understood. While we seek to understand the potential impacts of GEOs biologically and ecologically, we also need to be mindful of the broader social, institutional and cultural forces at work promoting the technology. David Orr, contemplating the fate of GEOs on the eve of the new century, made the case for such broader understanding and engagement aptly:

> We are entering a new era in science in which genetic engineering and biotechnology are taking center stage. Will it prove to be less destructive? I doubt it. On the contrary, given our present course, I think it has the potential to be even worse. We are on a course to repeat many of the same kinds of mistakes in biology that were made in the development of chemistry and for some of the same reasons of hubris, ignorance, greed and the reductionism that removes problems from their larger context." (1999, p. 229)

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APPENDIX C
NVIVO CODING DESCRIPTIONS

Information Sources *A parent node with children. Information Sources were coded for attributed pieces of information, facts or ideas in articles. This node includes child nodes: Direct Sources and Indirect Attributions.*	
Direct Sources (DS) *Direct sources are those used as information sources in the media articles. The journalist explicitly states them as the sources of information, facts, or ideas. They are visually coded in the documents in pink. Sources used merely as the subject of a sentence are not considered sources for information in news stories; there must be some kind of indication in the story that the journalist is getting information from the person or group for him/her/it to be a direct source.*	
DS-Other NGO	Non-governmental sources including financial policy analysts that are not part of the environmental NGO community following the GE debate. The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes include:*** Financial Sector, Press Club Officials, Independent regulatory consultants, and International Food Policy Research Institute.
DS-Biotech Industry	Industry sources used by the journalist--including companies' spokespersons, industry organizations, or industry scientists (who are identified explicitly or implicitly as such). The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes include:*** Biotech Companies, BIO, Advocacy Groups, and World Business Council.
DS-Environment	DS-Environment sources are those identified by the journalist as a source of information for the story and referenced in some way as an environmental group. The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes include:*** Environmental Defense Fund, Greenpeace, Foundation for Economic Trends, Friends of the Earth, Union of Concerned Scientists and PIRG.
DS-Government	Government sources used by the journalist--including agency spokespersons, government officials/officers, or US/Foreign diplomats and elected officials. The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes include:*** U.S. EPA, U.S. elected officials, UNDP, British Medical Association, U.S. FDA, foreign delegates, foreign elected officials, USDA, United Nations FAO, U.S. appointed official, NOAA, U.S. Justice Department.
DS-Academic	Academic researchers who are weighing in on one side or another in the GE debate. The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes***

	include: , Rayor & Carter, Andow, Gould, Obrycki et al, Oberhauser, Rice, Brower, Weiss, Dively, Calvin, Sears, Pleasants, Foster, Prakash, Renger, Berenbaum, Taylor, Bush, National Academy of Sciences, van Montagu, Somerville, Pusztai, May, Royal Society, Wolfenbarger & Phifer, McGloughlin, Hellmich, Stotzky, Ellstrand, Snow, Wilson, Bergelson & Purrington, Aldwinckle, Boehlje, Priest, Lawrence, and Arntzen.
DS-Consumer	Consumer and food safety groups who are cited as information sources in the articles. The journalist explicitly states them as the sources of information, facts, or ideas. ***Sub-nodes include***: Consumer Federation, general “consumers,” Consumer’s Union, Center for Food Safety.
DS-Farmers	Farmers and organizations representing farmers that journalists explicitly state as the source of information, facts, or ideas. Often the farmers are used to step the GE issue down to the field level. ***Sub-nodes include***: Farmer Groups, farmers.
DS-Protest Groups	Journalists citing individual activists or activists communities/organizations as the sources of information, facts, or ideas. Also reporting on activist claims of responsibility for civil disobedience or other protest activities.
DS-Polling Organizations	Journalists cite polls as sources of information about public acceptance of GE crops and to predict impacts of the GE controversy on GE crop plantings.
DS-Affiliation Unclear	A specific name and occupational title are given without specific reference to an organization, agency or institution.
DS-Other Industries	Industries and companies associated with biotechnology and have a stake in the outcomes of the GE debate. ***Sub-nodes include***: Food & grocery industry, food & grocery companies, home garden industry.

Indirect Attributions (IA)

Indirect attributions are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. These indirect attributions are used as the sources of information, facts, sentiments, or ideas by the journalist in the article. They are visually coded in the documents in violet.

IA-Protest Groups	Ambiguous attribution to protesters or opposition groups to GEOs. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Biotech Industry	Industry sources used by the journalist--including companies' spokespersons, industry organizations, or industry scientists (who are identified explicitly or implicitly as such). They are

	explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Environment	Sources identified by the journalist as a source of information for the story and referenced in some way as an environmental group. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Government	Government sources used by the journalist--including agency spokespersons, government officials/officers, or US/Foreign diplomats and elected officials. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Academic	Academic researchers who are weighing in on one side or another in the GM/Env debate. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Consumer or Public	Consumer and food safety groups who are cited as information sources in the articles. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Generic Researchers or Scientists	Generic reference to either researchers or scientists, where the affiliation or accreditation is ambiguous--makes the sourcing almost useless. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Opponents-Vague	Vague reference to opponents of GEOs (but without reference to protesting or protest industry. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Farmers	Vague references to farmers or farming groups. They are

	explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist in the article uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Experts of Some Kind Vague	Vague reference to "experts" without a specific attribution to a field of study or affiliation with a group. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist in the article uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Proponents of biotech	Vague reference to a source that is in favor of GEOs or biotechnology. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Food Industry	Grocer or food industry sources that are vague/not explicit. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist in the article uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Mass Media	Attributions to vague/nondescript media sources. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist in the article uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
IA-Religious Groups	Attributions to vague/nondescript religious groups. They are explicitly referenced in some way, but the attribution is somehow vague--a reader would not be able to trace the reference back to one specific group or person. The journalist uses these indirect attributions as the sources of information, facts, sentiments, or ideas.
Definitions & Discursive Elements *A parent node with children. Discursive devices and symbols that help define what frames are in the GEO debate. This node includes child nodes: descriptors & labels; problem or solution definitions; biotech or Bt definitions.*	
Descriptors & Labels *How journalists and major stakeholders describe issues, sentiments, and reactions. Also, how different groups are characterized or labeled in media accounts.*	
Characterization of Opposition	How opponents of biotech are characterized by journalists.

Characterization of Protests	How protests are described by the journalist.
Characterization of Research Findings	How the journalist characterizes a group/person's reaction to scientific research about monarchs, Bt, or risk assessment. ***Sub-nodes include***: Losey, Pre-commercial research, Pusztai, NAS pack of papers, Obrycki et al, EPA report, Wolfenbarger & Phifer, NAS 2000 report, Taylor-Brazil nuts, Biotech consortium
Anti-American Sentiment	Expressed anti-American sentiments in relationship to the GEO debate. Describing American business, regulations, and lobbyists as mistrustful or in other negative light.
Emotional Europeans	Emotive language used to describe Europeans' reactions to or feelings toward GEOs.
Environmentalists' Sentiments	How journalist characterizes the environmental groups' reactions to things--regulations, studies, industry activity, etc.
Industry Sentiments	How the journalists characterize how the industry groups or biotech companies are reacting to protests, research, & activities.
Public Sentiments	Journalist characterization of how the public perceives GEOs, an issue, a risk, etc. ***Sub-nodes include***: feeling for monarchs, confidence in regulations, feeling of unease or fear, public doesn't see benefits, public is uninformed, public is irrational, public doesn't want GEOs, public receptive to GE, public opinion is important, American public is apathetic, Am-Eur comparisons, dislike for biotech companies, labeling issues, and public relations issues.
Consumer/Grocer Reaction	Journalists' descriptions of how the consumers in general are reacting to GEOs. Also, how the consumer groups and grocers are dealing with the rising controversy over GEOs--either in their sentiments or in their actions on GEO ingredients.
Developing World Sentiment	Developing world issues or sentiments with GEOs...either described by developing world peoples, or attributed to them by others/journalist.
Farmer Sentiment	Describes farmer (both U.S. and European) reactions to GE crops and their plans for planting them during the years of the monarch controversy.
Government Reaction	Government reaction to new studies or to groups' assertions about the safety of GEOs--can either be reaction to something (e.g., official response to an accusation) or direct action in response to an event (e.g., reissuing permits).
Industry Action	Media's descriptions of how the companies react (actual actions) to events and scientific findings as they are released to the public (e.g., removing GE ingredients from baby foods, etc)
Responses to "Anti's"	How the journalist reports the response to protest groups or others who question the regulation and/or use of GEOs.
Responses to Cornell Research	How stakeholders respond to the Cornell study and how they characterize the study in the context of the debate. Can be direct

	attributions about the study or the journalists' descriptions of how others reacted.
Scientist Sentiment	How scientists are characterized as reacting to scientific findings or events.
Support for Biotech	Statements that support biotechnology and its goals in general.

Problem or Solution Definition

How journalists define the problem with GEOs; how they define the solutions proposed; what the realm of possibilities are in the journalists' minds. How journalists define CBA vs. precautionary principle. Any of the many issues surrounding the biotech issue that helps define or shape how the problems are constructed.

Americans are Clueless	Statements suggesting that Americans are, in general, uninformed about the foods they are eating or about the amount of GE that is currently going on in the world.
American Intransigence	Any suggestion that American companies or the government is forcing GE crops upon other peoples and countries and showing an unwillingness to acknowledge differences of opinion on the subject.
Battle/Conflict Rhetorics	Language the evokes the battle metaphor over GEOs. Also, language that perpetuates the "newsworthiness" of the story as one in which conflict exists. ***Sub-nodes include:*** anti vs. pro, antis as aggressor, proponents as aggressor, competing claims, specific battle language, farmers, controversial, protest, passionate emotive, destruction violence, philosophical challenges, reference to war or international conflict, U.S. vs. Europe (U.S. as aggressor, Eur protestors as aggressor, Eur protectionism, Eur jealousy of US), free trade issues, regulatory, debate, boycott/moratorium, attack Eur press, companies charging misrepresentation, companies as criminals, retreat/losing rhetorics
Cost-Benefit or Risk-Benefit Rhetorics	Any discussion of cost- (risk-) benefit analysis, or how society needs to weigh the potential benefits of the technology to the possible costs.
Conflict of Interest	Any description of the conflicts of interest that exist in the regulatory panel or by scientists that are being funded by industry or the government to do research. Also, any discussion of the so-called "revolving door" between industry and government.
Cost-Benefit of Monarch	Any discussion of how the monarch (or other butterflies) specifically weighs in to the cost-benefit equation for GEOs.
Early Days of GE	Argument that the technology is still rather new and the kinks still need to be worked out.
Ethical Questions	Discussion of the ethical or value-related issues for GE--either spiritual or developing-world, etc.
Farming Impact	How GE might impact the farming community

Feed the World	Argument that GE is the way the future will feed the world. Also, any analogies to the "green revolution" and GE being the next iteration of feeding a growing world population.
Free Market Regulation	The market will get rid of biotech if it does not prove to be safe or desirable.
GE Food Takeover	Notion that GE is already “out there” at levels that we don't even know (even in baby foods), and that the takeover of our food supply by GE has already begun or is perhaps inevitable.
Genie Out of Bottle	Ingesting GE food is inevitable. You can't recall GE foods or their genes once they are already out. Also, the notion that since the genie is already out, we should resign ourselves to the consequences and the inevitability of a GE future.
Global Trade Issues	Any discussion of the various trade issues related to GE and its non-acceptance abroad.
Humanitarian Rhetorics	Discussion of the potential for GE to meet the needs of humankind around the globe and the U.S. as a global humanitarian--using GE to further humanitarian missions globally.
Industry Consolidation	Discussion of industry (particularly food companies and seed companies) consolidation. Issue of creating monopolies in the food supply chain.
Manipulation by Government	Notion that government is manipulating policies or science or research findings to protect itself or the biotech industry. Also notions of conflict of interest.
Manipulation by Industry	Notion that industry is manipulating policies or science or research findings to protect itself or the biotech industry. Also notions of conflict of interest.
Patenting Issues	Discussion of ethical and practical issues surrounding the patenting of life and genes and the consequences of such an endeavor.
Playing God	Notion of GE being unnatural or in some way spiritually bankrupt.
Caution	Suggestions that we need to move ahead with caution. Also, discussions of the European approach to GE with the precautionary principle.
PR Problem or Mistake	The notion that the real problem in all of this isn't really science, but a public relations problem—i.e., people just don't understand the benefits and how much science has gone into production/ safety testing GEOs. Also, any discussion of the PR problems or missteps that individuals or groups made along the way.
Regulation	Any discussion of how GEOs are regulated nationally or internationally--including discussion of problems with regulation or of the extent of regulation. ***Sub-nodes include***: Regulations reduce risks, require more research, calls for moratoria, regulations lead to acceptance, U.S. regulatory trends, buffers in

	fields, labeling/notifications, should regulate as well as drugs, compel EU to accept U.S. reg. approach, can't force technology on people, international regulation, Cartagena, burdensome regs cause trouble, WTO, US/federal regulations adequate, EPA doing good job, regulators stand by decision policy, regs based on good science, federal regulations inadequate/insufficient, pressure for more regulations, Disillusionment with U.S. regs, skepticism over corporate regulation, revolving door, coercion of science, oversight of U.S. regulators, forcing restrictions, onerous to farmers, food safety, ag industry should be liable, lack of public information, regulatory funding/costs, and patents.
Rejection of Technology	Discussion of groups and people who "reject" the technology and the consequences of it (or, how the industry is dealing with the rejection).
Rising Concern	Descriptions of how the issue is becoming more salient in America or the world...especially how people are becoming more aware of the potential risks from GEOs and GE technology.
Substantial Equivalence	Any notion that GEOs are virtually the same as traditionally bred counterparts.
Serious Science	Notion that there has been a lot of serious scientific scrutiny of GEOs. Also, notions of safety because of perceived serious scientific scrutiny.
Technology for Rich	Notion that biotech is really for rich countries, multinational corporate profits, and rich farmers and there is nothing of real value in terms of developing world farmers, economies, or indig. peoples (nutrition).
Biotech or Bt Definition *The general background of GEOs, biotechnology, Bt; and how benefits and risks are defined.*	
Biotech Benefits	Claims made about the benefits of biotechnology--real, realized, or proposed. ***Sub-nodes include***: tools for farmers (new green revolution, pest resistant crops, virus resistance, herbicide resistance, thrive in hostile environments, deeper genome understanding), environmental benefits (reduction of pesticides, plastics production—petroleum, cleaner technology, less land in production, ecological benefits, improving nature), non-specific benefits (qualitative adjective), human health benefits (healthier food, imbedded vaccines, prevent cancer), market advantages (increased yield, faster growing, stronger plants, cheaper to grow)
Bt Benefits	Claims about the benefits of engineered Bt crops.
Bt/Biotech Descriptor	How Bt or biotech or the process of genetic engineering is described. May include some discussion about GE in relation to

	traditional breeding methods as well. ***Sub-nodes include:*** Bt descriptor (carries a toxin, produces a toxin, genetically altered, natural pesticide, butterfly killing corn, modified to resist, contain a gene, given a gene, endowed with gene, protects the plant), Biotech descriptor (more precise than traditional, crossing species barriers, tinkering, borrowing code, inserting genetic material, permanently altering genetic code, adding genes, agrobacterium naturally alters, gene gun, transfer genetic code, endowed with abilities, manipulating genetic code)
Biotech Handcuffs	Notion that the world has no choice but to accept biotechnology and biotech crops. Or, there will be little choice but to accept them as the way farming will be done in the future.
Acreage Planted	Claims about how many acres of GE agricultural plants are planted in the U.S. and world. May be used in some cases to illustrate the inevitability of a GE future.
Absolute Necessity	Claim that there is no other way to feed the world and protect the environment except to adopt GE agricultural products.
History of Biotech	Description of the history of biotechnology.
Risks and Safety *A parent node with children. This is the node into which were coded all of the discursive symbols and devices used to frame risks from GEOs--which includes safety arguments as well.*	
Ecological Risk *Description or enumeration of any of the many possible ecological risks from GEOs.*	
Comparisons-EcoTragedy	Making comparisons between genetic engineering and other disasters that have environmental impacts: nuclear power, population explosion, invasive species, etc.
Non-Target Risk	Discussion of the possible impacts to species or ecosystem functions that are not the immediate subject of the transgene. ***Sub-nodes include:*** monarch risks, other non-target insects, soil damage or contamination, multi-trophic interactions
Insect Resistance Evolution	Discussion of resistance evolution due to prevalence of GE crops—in particular to Bt resistance.
Super-Weeds/Bugs	Discussion of potential to create super-weeds and –bugs as a result of evolution of resistance or conferring some kind of fitness advantage to unintended species or wild relatives. ***Sub-nodes include:*** outcompete other species, removing ecological controls, creation of super diseases
Gene Transfer	Discussion of the potential for gene movement as a result of transgenic crops. ***Sub-nodes include:*** genetic pollution, gene transfer to the wild.
Conflicting Research	Highlighting the differences of opinion or conclusions drawn by researchers.
Ecological Risk	The science behind ecological risk assessment and the specific

Assessment and Reduction	measures taken to reduce ecological risks. ***Sub-nodes include:*** Threat of unanticipated risks, companies must ensure eco safety, risk assessment research explained, refuges reduce risk, irreversibility of risk, sub-lethal impacts
General Eco Risk References	Vague or ambiguous references to ecological risks. ***Sub-nodes include:*** general reference to eco risk, risk of not employing GE, lack of studies that suggest eco harm, more research is needed, GE as act against nature, fragile species or ecology
Other Monarch Risks	Description of the risks to monarch butterfly populations--Bt pollen and otherwise.
Food & Health Safety Risk *Many kinds of food/consumption/health risks are brought into question with GEOs. Coded to this node are references to consumer unease, arguments about food safety and risk, compromised nutritional value, the level of research conducted about food safety and allergies, and food regulation.*	
Organic Farm Risk	The risks attributed to organic farming from GEOs--including financial damage, crop damage, third-world indigenous issues, contamination of fields, etc.
Comparison-Food/Drug Tragedy	Comparisons of GEO debate with previous debates or crises in food or medical safety, e.g., mad cow, etc.
Economic Concern or Risk	Discussion of economic risks--to companies or farmers or nations--from GEOs.
Risk--General	General, non-specific, or vague discussion of risks from GEOs--health, environment, food safety, or otherwise.
Role of Science in Risk Regulation *Addressing the role of science in formulating the public policy that protects human health and the environment.*	
Risk Assessment is Complex	Descriptions of the complications of risk assessment science.
Scientific Uncertainty	Any description of the uncertainties of science in risk assessment or in description of risks from GEOs.
Serious Science	Notion that there has been a lot of serious scientific scrutiny of GEOs. Also, notions of safety because of perceived serious scientific scrutiny.
Safety Endorsement	Any group or individual statement that suggests that GEOs are safe (food or environment). Sub-nodes include: not serious threat, no evidence of harm/no evidence exists, generic safety, substantial equivalence
Questionable Science	Any suggestion that the science being used/cited is questionable in some way--either due to methods or conflict of interest.
Lack of Research	Notion that conclusions really can't be reached because there is insufficient research on GEOs.
Cost of Risk Assessment	Discussion of the economic costs of risk assessment.

APPENDIX D
REPRINT PERMISSIONS

"SuperVeggies" by Brad Hamann

On Aug 23, 2008, at 12:02 PM, Erika Rivers wrote:

Brad:
You did an illustration for the Washington Post for an article called "The Dish on Biotech Food" (P. C15, KidsPost, May 30, 2001). It is this really great illustration of a super-hero tomato and ear of corn--and it expresses the framing of the biotech food issue back in the early part of this decade wonderfully.

I am finishing up my doctoral dissertation on media framing of the biotech food issue--specifically how the media framed ecological risks to the monarch butterfly from Bt corn pollen. One of the frames I discuss is something I call "Super Science"--it deals with the notion that with the new abilities of biotech "super science" comes super complex problems that are kind-of lurking in the background unexplored. This illustration of yours perfectly illustrates this concept with the superhero vegetables transposed in front of a star-burst of technology that is a bit unknown in the background.

Bottom line: I'd really like to use this in my dissertation to illustrate the point. May I have permission to do so? If so, would there be a charge to use the image? Also, can I get the image electronically? The permission I am seeking is for one-time use for academic purposes only. There will be two copies of the dissertation printed--one to be housed in the UofM library and one housed with the UofM graduate school. If for some reason I would choose to publish subsequent articles on the topic, I would certainly seek further permissions from you to use the image.

Thanks for your consideration.
Best,
Erika
PhD Candidate, Conservation Biology Program, University of Minnesota

On Aug 23, 2008, at 12:33 PM, Brad Hamann wrote:

Hi Erika,

Thanks for your interest in my work. I'd be more than happy to allow you to use my illustration under the terms you described, and I can supply you with a very nice high resolution image. I'm working on an MFA thesis of my own, and people have been very generous with their time and materials, and I believe on passing it on.

Just make sure I have a visible credit somewhere, with maybe my Web site URL. Let me know what format, and what resolution would be best for you. A good sized 300 dpi jpeg would probably work.

Best,
Brad

Brad Hamann Illustration & Design, 28 Aspinwall Road, Red Hook, NY 12571
845.758.6186, bhamann@hvc.rr.com, www.bradhamann.com

From: Erika Rivers [mailto:Erika.Rivers@dnr.state.mn.us]
Sent: 23 July 2009 17:01
To: David Hemming (TL, Biotech.)
Subject: Reprint Permission

David:
Karen Oberhauser and I wrote a review of the Bt Corn-Monarch butterfly toxicity research in 2003 (see citation below).
I am now completing my PhD Dissertation, and would like to include part of the article in a dissertation chapter covering non-target impacts research for Bt corn. What must be done to gain reprint permission?
At this time, the only permission I'm seeking is to include the work in the dissertation, which would be published in hard copy for the University of Minnesota Library and the online dissertation search site.
Please advise.
Erika

Oberhauser, K. and E. Rivers. 2003. Monarch butterfly (Danaus plexippus) larvae and Bt maize pollen: a review of ecological risk assessment for a non-target species. AgBiotechNet 5(117): 1-7.

On Jul 23, 2009, at 11:06 AM, David Hemming wrote:

Dear Erika
That's fine – I hereby give permission on behalf of CABI for you to use the paper in your dissertation chapter. Let me know if you require anything more formal, but this email will suffice for our purposes.
Kind regards,
David
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