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Ecologically based goal setting in mangrove forest and tidal marsh restoration

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Abstract

The history of goal setting in marsh and mangrove restoration projects is outlined and suggested to have included three phases. The first was the initial experimental phase where 'persistent vegetative cover' was the primary goal. Following the routine achievement of that criterion, coastal restoration entered a new phase where wetland compensatory mitigation became the primary driving force and 'functional equivalency' was considered the ultimate goal. We have now entered the third phase where 'ecological restoration' and 'ecosystem restoration' are the buzzwords. Using case studies in southern Florida, it is suggested that the political will is not there to properly fund effective wetland compensatory mitigation programs and thus the success of these is marginal and cannot be expected to improve. Wetland regulatory programs are still needed, but the future of coastal wetland management is more likely to be successful with an emphasis on conservation and restoration programs with mitigation/compensation being only one small part of the entire program. Ecologically based goal setting will be an important future element of successful non-regulatory wetland management programs.

Keywords: Tidal marsh; Mangrove forest; Restoration; Compensatory mitigation; Coastal wetland management

1. Introduction

This short communication is a synthesis of facts and of opinions of the author based on 25 years of hands-on work with wetland restoration and management, largely in the USA. I present it as food for thought and welcome comments and criticisms. My intent is to ultimately improve the management of the wetland restoration process such that failures are fewer, and successful restoration becomes the norm, not the exception.

The establishment of realistic, quantifiable ecologically based goals is basic to the planning process for all wetland restoration and creation projects (Erwin, 1990). For mangrove forest and tidal marsh restoration and creation, the process of goal setting has a long and chequered history. Dating back as far as 1972, papers published on direct seeding and planting of smooth cordgrass (*Spartina alterniflora* Loisel.) have emphasized the rate of expansion of the rhizomes of individual plants to achieve '100% cover' within one or two growing seasons and thus the physical appearance

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of a natural marsh. This was an achievable goal with plantings on man-made dredged material islands on the mid-Atlantic coast (Broome, 1972; Woodhouse et al., 1972). Similarly, the survival of planted mangrove seedlings was a basic criterion for success in more tropical coastal wetland restoration projects (Lewis, 1982).

As techniques were improved and establishment of tidal marshes and mangrove forests became routine, at least on the east coast of the US, for such purposes as stabilizing dredged material or restoring lost or damaged habitats (Landin et al., 1989), the concept of wetland mitigation started to drive the process. It was natural, then, that questions arose about the 'functional equivalency' of restored wetlands when the activities leading to their establishment arose from a legal process resulting in the loss of another wetland and the 'no net loss' idea became ingrained in national wetland management policy. The science of functional analysis, however, has lagged far behind the rate at which wetland losses are permitted; therefore, goal setting and success criteria have been set largely by an ad hoc process derived from individual permit application submittal, processing, and issuance. No generally accepted and applied criteria for establishing goals for coastal wetland restoration projects exists even today. Further complicating the process is the confusion created by trying to differentiate between goals and success criteria for voluntary habitat restoration, just to restore the nation's wetlands, and legally required habitat restoration to offset permitted losses (see Lewis (1992), Thayer (1992)).

The lack of a universally accepted goal setting procedure means that each project, specifically its purpose, faces complex reviews by multiple agencies with a wide range of training and experience with restoration, and even with the basic biology of the plant community being discussed. This has led in the past to a consensus process to allow a project to proceed with all permits in hand only after lengthy negotiations that often produce goals translated into success criteria or 'specific conditions' written into permits. These were often unrealistic, unachievable, or just not based on ecological reality. Worse, the focus on goals often overshadows the appropriate review of the proposed design, which, if flawed, can lead to a thoroughly reviewed and intensely debated project that has no chance of achieving success from day one of the construction process.

2. Case studies

Such a project was proposed as mitigation for mangrove forest impacts as part of the widening of US 1 between Homestead and Key Largo in South Florida (Dade and Monroe Counties) (Figs. 1 and 2). The proposed widening of a two-lane road to four separated lanes, and associated replacement of several bridges, involved a complex design and permitting process that began in 1990 and is still underway today. A decision was made to apply for permits to construct the wetland mitigation areas separately from the permitting for the construction impacts. Permits for the mitigation areas were issued in 1994 (South Florida Water Management District Permit # 13-00013-D, Corps of Engineers Permit # 199302368 (IP-TB)) and construction of the mangrove mitigation areas was completed on March 1, 1995. This effort was designed to complete mitigation in advance of the construction impacts, an admirable goal. However, permits for the construction of the road and bridges have still not been issued, and the Jacksonville District of the Corps of Engineers has indicated it will deny the permit. In response to this threat, FDOT has withdrawn its permit application to widen US 1; therefore, the mitigation project discussed here is not currently serving as mitigation for any permitted impacts.

In spite of intensive and expensive wetland restoration design work, followed by two years of regulatory agency reviews, changes to the plan, and further negotiations, the mangrove restoration plan was fatally flawed. This fatal flaw was due to incomplete specifications for the constructed ground level elevations (Figs. 3 and 4). Fig. 3 shows the original design, with the final design grade not specified. The concept was to simply remove the historical fill placed at the site, and reach the appropriate grade for natural mangrove recruitment. Fig. 4 shows the revised plan with very specific final grades indicated. These were determined based upon actual surveying of the ground elevations of existing mangroves in the vicinity of the project. This kind of design error is the most often cited error in mangrove and tidal marsh restoration design (Lewis, 1982, 1990; Crewz and Lewis, 1991).

The primary success criterion was the achievement of '80% total coverage by mangrove and associated jurisdictional species...at the end of two years from the completion of final excavation'. In addition, one of the basic goals of the project was to restore habitat for the endangered American crocodile (*Crocodylus acutus*), a species that requires open water to traverse mangrove areas and feed on its primary food, small to medium-size estuarine and marine fish, depending on the size of the crocodile. In spite of this, the initial permitted design did not include constructed tidal streams into the main bodies of water on site. These project design errors were only detected when brought to the attention of the construction project personnel just 2 weeks before construction had to begin and they were to

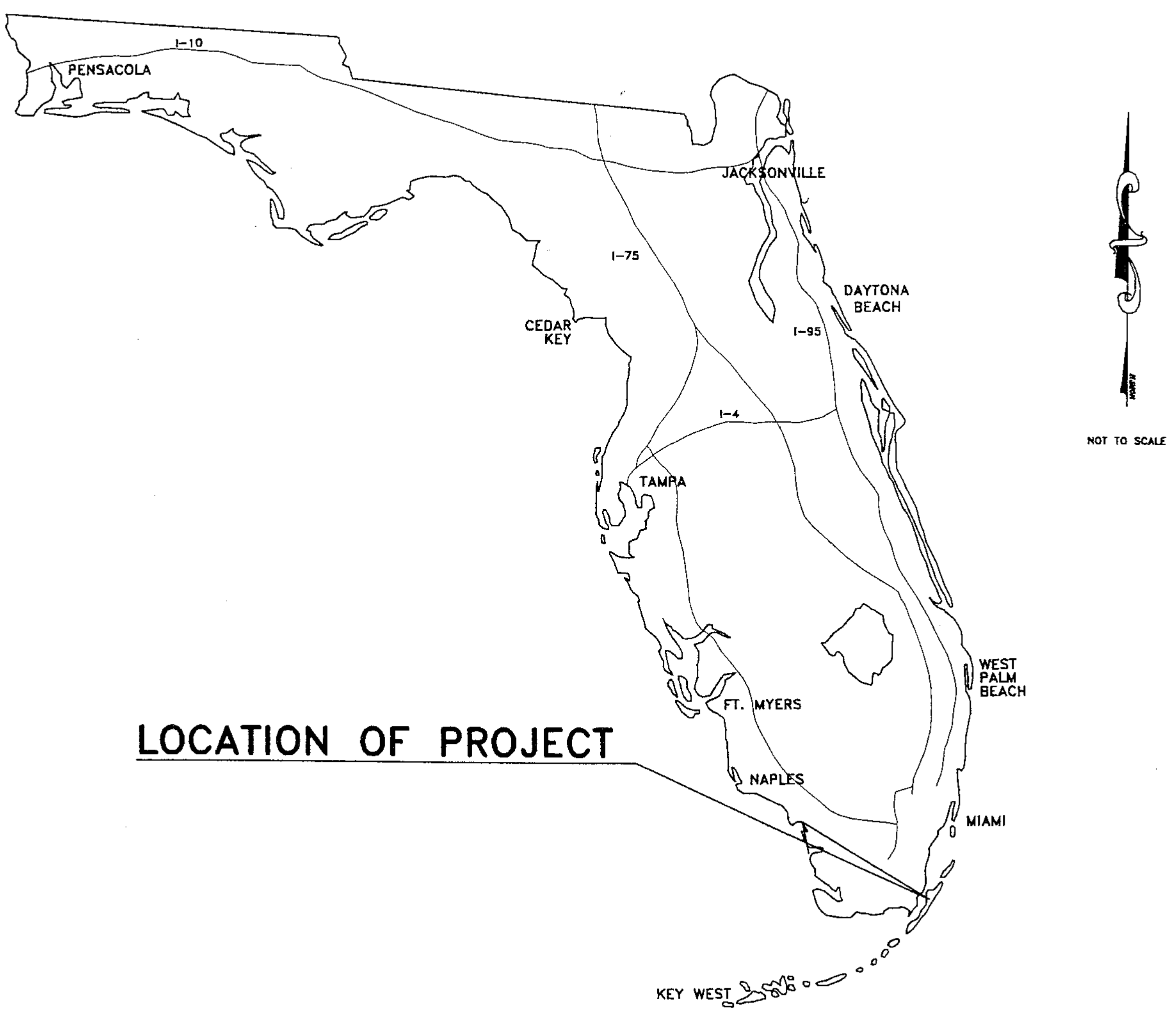

Fig. 1. Harrison Tract mitigation project location in South Florida.

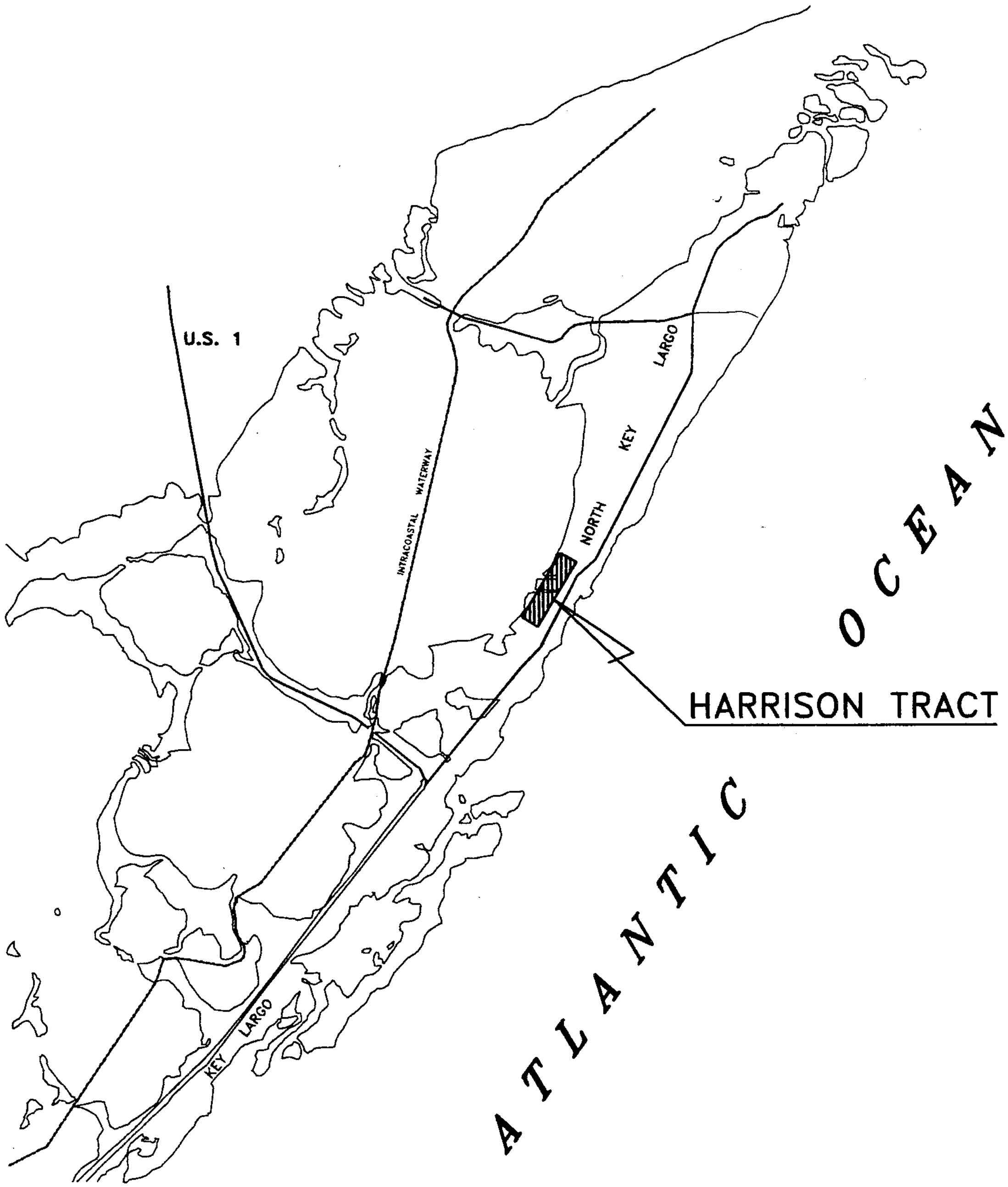

Fig. 2. Harrison Tract mitigation project location on North Key Largo.

be completed within a 6-month non-breeding season time window! Needless to say there were many denials and extensive finger pointing, but ultimately the project design was changed and proved successful, at a total final cost of US$4.75 million. But how close did it come to being an expensive failure? How did a major design flaw survive despite years of review by dozens of professionals?

Another project, the restoration of coastal wetlands, including seagrass in the Florida Keys at 25 locations along the entire chain of islands as mitigation for construction impacts from the replacement of 37 bridges, had as a goal to provide compensatory mitigation for 20 ha of mangroves and 37.2 ha of seagrass lost during construction (Lewis et al., 1994). The key to the success of this mitigation effort and meeting the goals were small-scale test areas implemented to determine what methodologies might prove successful (Jor-

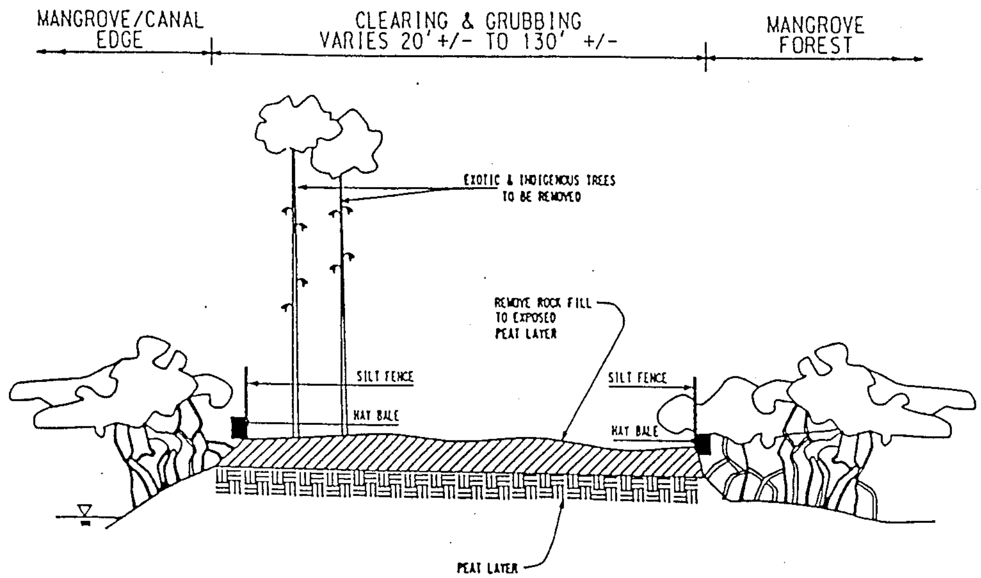

Fig. 3. The original permitted design cross section of the mangrove mitigation area excavation (note the lack of specific elevations relative to a benchmark).

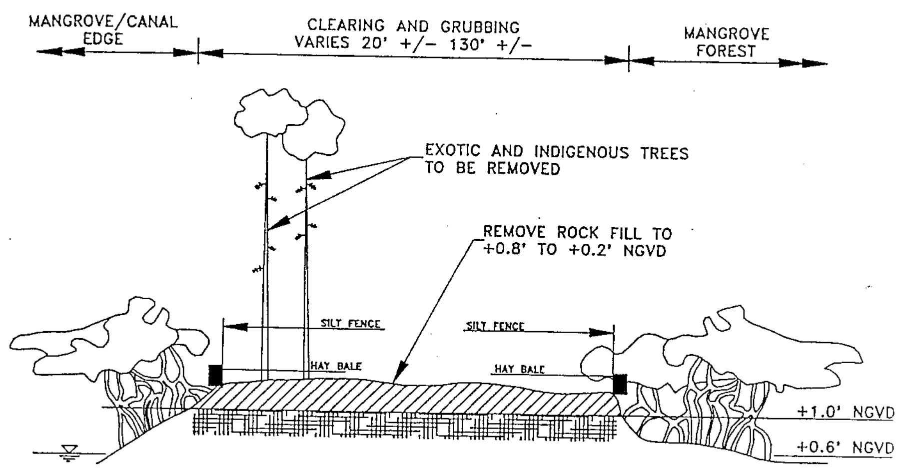

Fig. 4. The revised design cross section of the mangrove mitigation area excavation at the Harrison Tract (note the placement of very specific elevations relative to national geodetic vertical datum (NGVD)).

dan, 1986; Lewis, 1987) and realistic expectations based upon ecological success criteria. As a result, nearly 320 ha of partially to completely closed coastal lagoons were reopened and 13.2 ha of mangrove habitat and 53.6 ha of seagrass habitat restored.

Similarly Weinstein et al. (1997) outline the process used to provide compensatory mitigation to offset the loss of fish from a once-through cooling system at a proposed power plant on Delaware Bay. They emphasize that the decision to restore 4050 ha of degraded tidal marsh was made with an ultimate goal of offsetting the entrainment and loss of estuarine fish species through use of 'ecological criteria' of increased net above-ground productivity of marsh vegetation and the resulting increased secondary productivity of four fish species affected by the entrainment problem. A single success index based upon combining a number of measurements was developed using reference marshes in various states of 'self-restoration'.

Haltiner et al. (1997) recount the extensive experience in southern California starting with a goal of 'rapid establishment of vegetation cover' as the primary success criterion in 'first generation' tidal marsh mitigation projects in the 1970s as noted in my introductory statements above. Second generation projects capitalized on the lessons learned from previous projects and the criticism that there 'has been a lack of clearly defined and measurable goals to judge success and project compliance' and a '...lack of adequate monitoring programs to measure project performance and functional attributes'. The mitigation and monitoring program in the Sweetwater Marsh National Wildlife Refuge in southwestern San Diego Bay described in detail by Haltiner et al. (1997) is a model for such efforts nationwide. Unfortunately, in my opinion, it is a model that is not likely to be used due to the long time frames and detailed monitoring instituted and the resulting costs.

3. Discussion

In my opinion, it is a failure of the permitting process to focus on ensuring successful construction of wetland restoration projects that produces potential or actual failures like that described above for the Harrison Tract. The focus, all too often, is on things like mitigation ratios, or whether the project should be permitted at all. These items need to be dealt with first, and are certainly important, but should be decided, and then put aside. The details of the construction of the mitigation area can then be the single focus of the effort to compensate for the unavoidable impacts of a project that is to be permitted. For restoration projects not associated with some permittable impact (i.e. restoration for the sake of restoration), the permitting process should not obscure the goal of the project to restore habitat.

The failure to train and re-train permitting staffs in the need to connect ecologically sound goal setting with appropriate and proven successful restoration design technology all too often leads to permits destined to fail or only partially achieve their stated goals. As noted in the National Academy of Science report entitled 'Restoring and Protecting Marine Habitat—The Role of Engineering and Technology' (National Academy of Sciences, 1994), 'The principle obstacles to wider use of coastal engineering capabilities in habitat protection, enhancement, restoration and creation are the cost and the institutional, regulatory, and management barriers to using the best available technologies and practices'. Improvement in the success of wetland restoration projects has often been linked to the need for more science (see Haltiner et al. (1997)), but Seneca and Broome (1992) state that 'all this knowledge of marsh restoration is of little use unless it is incorporated into contingency plans and management decisions to insure utilization'. They go on to state that 'communication among those who develop restoration technology, those who ensure its use, and those who use it is paramount to successful restoration...'. I agree, and believe the lack of widespread training of regulatory staff of agencies in the state-of-the-art of wetland restoration ethods and common mistakes, are major hurdles to achieving more successful wetland restorations.

It is becoming abundantly clear that the original idea that compensatory mitigation programs

Table 1
The seven steps of a successful wetland mitigation/compensation program

1. Policy development
2. Regulation (permitting program)
3. Training and retraining staff
4. Program monitoring
5. Compliance monitoring
6. Enforcement
7. Adaptive management

could play a major role in achieving 'no net loss' of wetland area and functions in the US is not valid, and that the programs have not worked, and in my opinion, will not work. A properly implemented program requires seven critical components (Table 1). The political will to adequately fund and staff the regulatory program necessary to do the job has not been there. Only components # 1 (policy development) and # 2 (development of regulations) typically receive the emphasis needed. Without training and retraining (# 3), program monitoring (# 4), compliance (# 5), enforcement (# 6), and adaptive management (# 7), wetland compensatory mitigation programs will continue to fail to achieve their stated goals. This is not to suggest that wetland regulatory programs should be abandoned, but to suggest that they are only one of five critical components in a wetland conservation and restoration program (Table 2), most of which are voluntary and proactive, instead of regulatory and reactive.

Table 2
Proactive versus reactive approaches to a wetland conservation/restoration program

Wetland conservation/restoration program
Proactive
Protection and management of existing public lands
Purchase and management of private lands to expand the public land base
Cooperative management projects with willing private landowners
Habitat restoration outside a regulatory context
Reactive
Compensatory mitigation including in lieu fee programs to support proactive approaches

4. Recommendations

Based upon these case studies and the wetland management experiences of the author, I would recommend that ecologically based goal setting for coastal habitat conservation and restoration programs (Table 2) as well as coastal habitat mitigation/compensation programs (Table 1) be formalized by the federal resource management agencies and cooperating state and local agencies to include specific goals tied to the plant and animal communities that have been historically impacted, as well as those proposed for impact within a permitting program, with these 'Generic Goals': (1) Achieve success through sound application of the most up-to-date management and restoration technologies. (2) Assure ecologically sound restoration through application of the principles of landscape ecology. (3) Assure cost effectiveness of restoration plans. (4) Design and plan for a persistent landscape feature.

All of these require that the historical alterations of local coastal plant communities and the resulting changes in the abundance of fish and wildlife be proactively evaluated to insure successful restoration and persistence of managed coastal plant communities. The development of a rational ecosystem restoration program for a given management area is one such approach.

A program of this type might resemble that developed by Lewis Environmental Services, Incorporated and Coastal Environmental, Incorporated (1996) for the Tampa Bay National Estuary Program. This document suggests a long-term (i.e. 100-year) preservation, management, and restoration program for Tampa Bay that is based upon the habitat requirements of 10 guilds of fish and wildlife selected by a community-based consensus process and an analysis of historical changes in coastal plant community areal cover and distribution. It represents the 'third generation' of coastal habitat management and restoration programs and is financially feasible, ecologically based, and defined by quantitative measures of success.

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