Florida Keys Wetlands Evaluation Procedure ("KEYWEP")

SHORT COURSE TRAINING MANUAL

by
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Patricia McNeese
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for
the State of Florida
the County of Monroe
associated local governments
and Federal agencies

7 – 9 May 2024

through
the U.S. Environmental Protection Agency
Region 4 Laboratory, Athens, Georgia

with
Peter Kalla
Morris Flexner and Jerry Ackerman

Sponsored by
County of Monroe and City of Marathon

CONTENTS

Page

DEFINITIONS FOR KEYWEP FUNCTIONS

Page 3: Sediment Removal -- Filtration of suspended solids from runoff generated by rain events.

Page 3: Toxicant Sequestration -- Storage of heavy metals and toxic organics in sediment and woody vegetation.

Page 3: Nutrient Removal -- Uptake of soluble forms of nutrients by plants, and binding of PO_4 in carbonaceous substrates.

Page 3: Shoreline Anchorage -- Dissipation of wave energy, prevention of direct contact between moving water and the soil surface, and stabilization of the shoreline profile by vegetation.

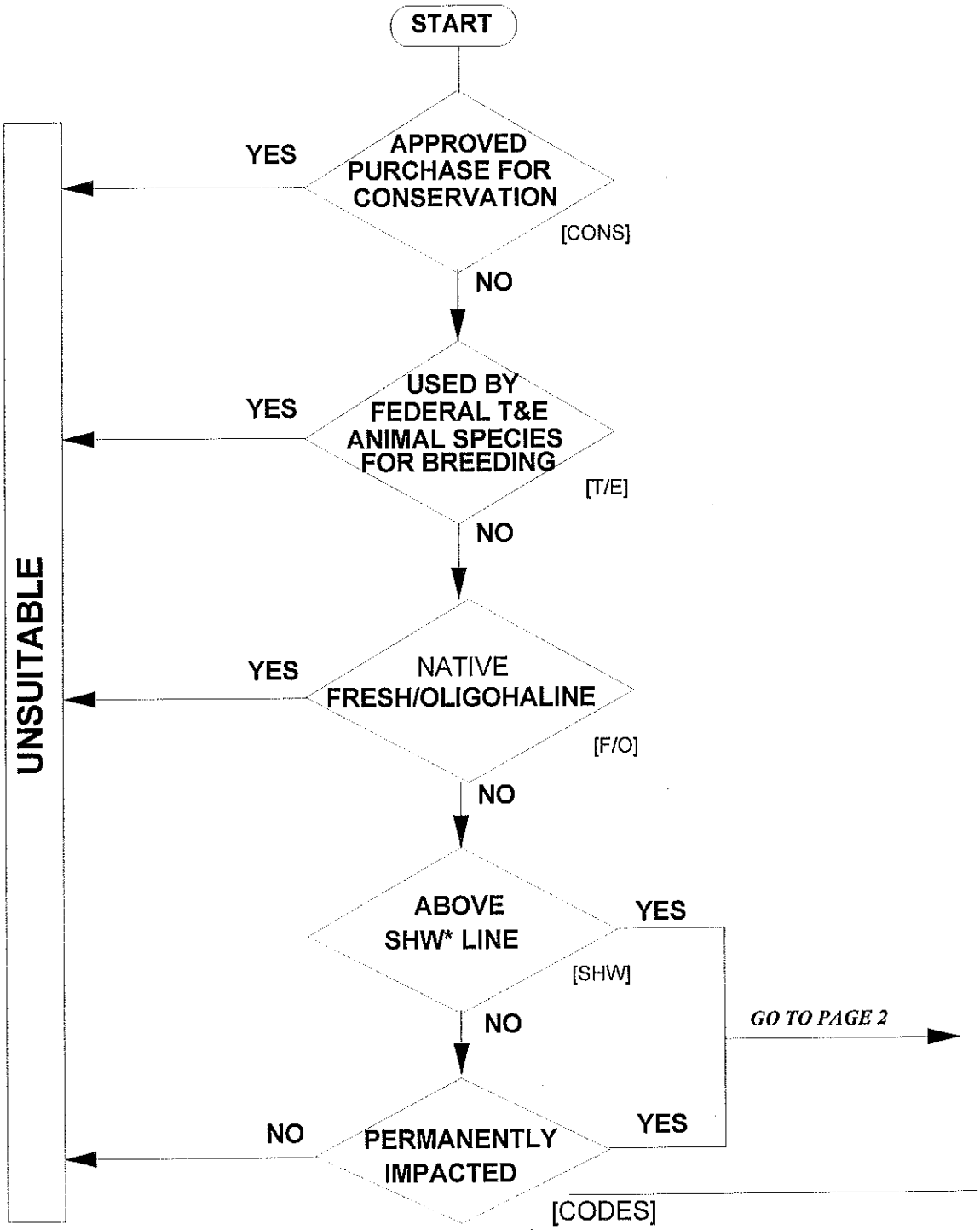
Page 4: Stormwater Infiltration -- Downward movement of direct precipitation or storm runoff into the soil or bedrock.

Page 4: Stormwater Detention -- Increase in the time elapsed between a storm event and the subsequent entry of runoff into inshore/nearshore surface waters.

Pages 5 & 6: Habitat Provision -- Support of animal populations by furnishing escape or resting cover, nesting substrates, or foraging sites.

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)

PAGE 1 OF 6: "RED FLAGS"



GLOSSARY FOR KEYWEP

Page 1 -- Red Flags

Assessment Area (AA): All adjoining wetlands that are driven by the same common, shared hydrologic regime.

The AA is delineated by identifying physical points of hydrologic change, including natural or man-made barriers and points where the gradient changes rapidly. Water exchange may take place daily, seasonally, or anywhere in between but it must be evidently regular. Storm-driven connection does not count as exchange. Where a barrier is present in such a way that it is evident that two wetlands are not regularly connected by hydrologic interaction, then they should be assessed as two separate AAs. In the Keys the primary exchange of water is tidal. Ponds, sloughs, and other depressional wetlands may have a groundwater component to their hydrology. Obvious gradient changes to areas above the seasonal high water line (non-tidal vegetative communities) will usually define the landward edge of the AA. For the purposes of this assessment, the seasonal low water line will be used as the surface water wetland boundary for wetlands bordering canals or open oceanic or gulf waters.

The AA for a small wetland will be easily identified. Where there are ponds or sloughs present, these water bodies are included in the assessment area.

The AA for a large wetland will be more difficult to identify and may require use of aerial photography. It may be necessary to sample several subsets of these AAs.

As indicated by the definition of AA and the sub-models for flagged areas, an AA can contain red flags but not green flags. It is intended that KEYWEP be run on an AA containing red flags as if they were part of that AA.

See also page 34 of this manual.

Approved Purchase for Conservation: Wetlands owned or approved for purchase from a willing seller by any public or private entity for the primary purpose of conservation. Permanently impacted (see below) wetlands adjacent to an undisturbed upland purchase are excluded from this definition.

The list of conservation entities includes, but is not limited to, U.S. Fish and Wildlife Service, DNR State Lands, DNR CARL program, The Nature Conservancy, Trust for Public Lands, Florida Keys Land and Sea Trust, Preservation 2000, and South Florida Water Management District Save Our Rivers Program. If only part of an AA is purchased for conservation, that portion is automatically a red flag.

Threatened and Endangered Species: Any animal designated as threatened or endangered according to the most recent listing of the U.S. Fish and Wildlife Service or the Florida Game and Freshwater Fish Commission.

Use of a wetland area by any such animal shall be evident by documented record on file with any local, state, or federal agency or other recognized repository of biological field information, such as the National Audubon Ornithological Research Unit, the Nature Conservancy Florida Keys Field Office, or the Florida Keys Audubon Chapter, or by strong physical evidence of presence or use (droppings or prints, nests, etc.).

"Potential for use" (KEYWEP Page 5) is equated to presence of required habitat that is sufficiently undisturbed and of adequate size and proximity to a known population, based on range information on file in the Keys Field Office of the Florida Game and Fresh Water Fish Commission, the Monroe County Environmental Resources Department, the local scientific literature, and best professional judgement of the ADID field team. Lists of species and the habitats they use accompany KEYWEP.

Native Fresh/Oligohaline: Natural wetlands exhibiting surface water salinities of 5 parts per thousand or less at any given time of the year, but not necessarily year-round; or wetlands that are vegetated with sawgrass (Cladium jamaicense), cattails (Typha spp.), and/or spike rush (Eleocharis spp.)

MEMORANDUM

TO: Vincent Condon, Functional Assessment Coordinator
Florida Keys ADID

FROM: Dr. Peter Kalla, Project Officer

RE: Definition of "Native Fresh/Oligohaline" red flag in KEYWEP assessment model

DATE: 28 March 1996

Vince --

Per our conversations of this morning, here is a revised working definition for your use. I will edit the original definition later, in the TSD. This verbage is sent to clarify the original intent of the KEYWEP developers.

Native Fresh/Oligohaline: Naturalized wetlands on marl or caprock substrates that exhibit surface water salinities of 5 parts per thousand or less at a given time of year, but not necessarily year-round, or that are vegetated with freshwater species such as sawgrass (Cladium jamaicense), cattails (Typha spp.), or spike rush (Eleocharis spp.). These wetlands can arise with time on ponding areas in the presently undisturbed interior of developed keys, where native salt marsh may have once existed. For example, marl is deposited by blue-green algae living in second-growth spike-rush marshes. In contrast, dredge-and-fill canal lots are not naturalized.

On an un-related note, FYI the aerials that I still have are numbers 195, 196, 198, 199, 200, 201, and 202, from the Grassy Key - Crawl Key area. I'll return them tomorrow.

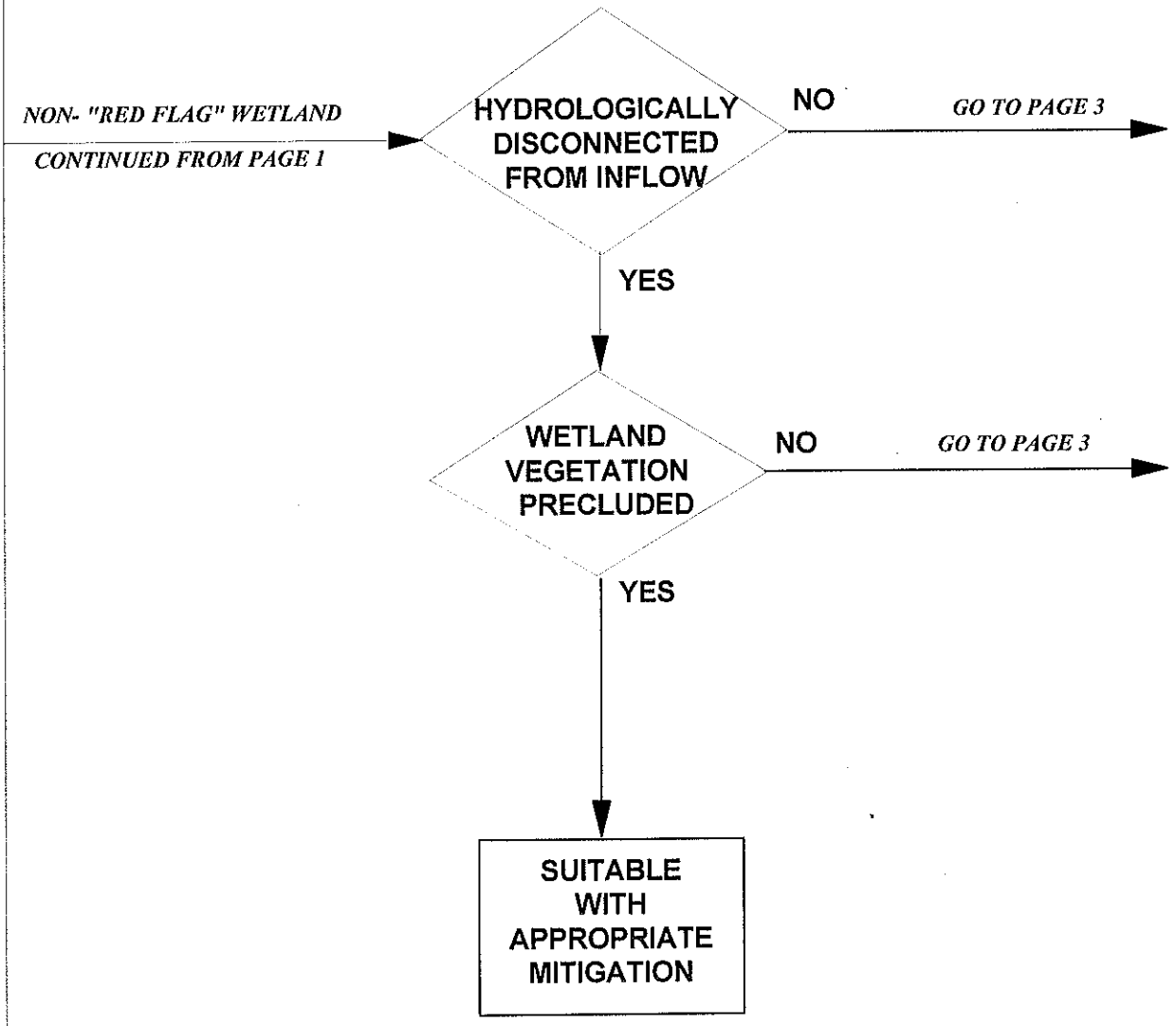
Seasonal High Water (SHW): The landward edge of the supratidal ecotone.

Can be determined by identifying the vegetative indicators of the supratidal and nontidal habitats given in the list of cover types. Seasonal water connection may be surface or subterranean. Therefore, it is possible to identify a supratidal wetland landward of a nontidal habitat. Wrack lines produced by equinoctial tides and seasonal wind effects may also be used to locate seasonal high water.

Permanently Impacted: Topographically altered such that succession to the original wetland community is not likely.

The original hydrologic input to the wetland is absent. Impacted areas typically are covered with silty or gravelly fill, are above daily tides, and lack evidence (near-surface saturated soil) of subterranean tidal influence. An area may have locally or temporarily disturbed soil or vegetation resulting from vehicular use, trash dumping, mosquito ditching, mowing, cutting,etc., without being impacted.

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)
PAGE 2 OF 6: "GREEN FLAGS"



Hydrologically Disconnected: Hydrologically altered such that persistence of the original wetland community is not likely.

Alteration can be the result of diking by roads or spoil banks, drainage by mosquito ditches, or filling that changes a hydroperiod or frequency of tidal inundation. Hydroperiod refers to frequency, duration and depth of inundation in freshwater wetlands. The concept of hydroperiod can also be applied to supratidal brackish waters. Disconnection is demonstrably obvious in filled waterfront lots, where the frequency has decreased from that of average tidal cycles to that of major storm events in some cases. Effect of sea level rise is excluded from this definition.

Wetland Vegetation Precluded: Not providing evident support for rooted macrophytes or algal mats, *as indicated by* groundtruthed classification of remote sensing data, consensual interpretation of aerial photography by the functional assessment team, or consensual field evaluation by the functional assessment team.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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28 October 1997

TO: Ms. Jeanette Hobbs
Monroe County Environmental Resources Department
2798 Overseas Highway, Suite 400
Marathon, FL 33050

RE: Further Guidance on Use of KEYWEP for the ADID Project

FROM: Pete Kalla

Dear Jeanette:

Here are some of my notes from EPA's last visit to the Keys.

Thank you for your help with organizing EPA's field work during that trip. The following guidance is from thoughts noted in the field while running the KEYWEP model. The EPA crew ran the model on the 39 AAs at which Page 3 was skipped by the Functional Assessment Group early in the Project. As we discussed during the week, EPA also ran it on 5 other nearby AAs to save the Group those stops later. Otherwise, these recommendations are given in no particular order. Information that clarifies the original KEYWEP Glossary is in *italics.*

1. It is hard to discern the species of vegetation on the new REDI maps of acreage tracts that were photographed at smaller scale (larger areas fitted onto one page). The CIRs should be used as ancillary information, particularly now that Phil has them on rollers on a light table. Any other photos (old REDIs, DNR State Lands collection, etc., if not obsolete because of successional changes, exotic invasion, human disturbance, etc.) should also be used if available. The Group should "train" on these images by matching their local knowledge to signatures on the images of known locations. The Group can then photo-interpret images of unknown locations, to categorize the vegetation into the species categories of the roughness variable in KEYWEP (Page 3, WQV3), when remotely assessing acreage tracts.

2. It has been pointed out that the model does not allow for combination of roughness categories, and that there is no variable for "interception of precipitation." The predominant (as judged by the Group) species or physiognomic category *in the first inch above the ground* (including stems, prostrate leaves, and aerial roots) should be used for roughness. If high and

minimal roughness species are co-dominant, the value for interim roughness should be used. [Percent cover (Page 3, WQV2) is based on the ground coverage of all species combined.]. KEYWEP Page 3 was designed to address filtration of run-off, not attenuation of flood flows or storm tidal waves, or interception of precipitation. However, if the source of surface water is solely on site, i.e. direct precipitation instead of any run-off from developed or scraped areas, then the interim roughness value could be used if tuft-forming grasses (species of interim roughness with high interception capability) predominate. This scenario presumes that interception attenuates run-off – that the vegetation would hold more water than that necessary to saturate the ground and begin running off. Another extreme example: A closed canopy of mature buttonwood trees growing on bare ground [effectively, low roughness (for run-off) and high interception] could be scored as complete coverage of interim roughness (100% x 0.5) in the above scenario.

3. Thanks for acknowledging receipt of the soil probe I recently sent you. A probe proved very useful to the EPA crew: It's much more accurate and efficient than scratching at the ground with your foot for examining the substrate (Page 3 and Page 4).

Regarding substrates and Pages 3 and 4 of KEYWEP, a note of caution (to reiterate a recent conversation I had with Phil): The model does not allow for certain combinations of values for WQV1 and SWV1. In particular, if 0.5 is correctly entered for WQV1 on Page 3, then a value of 0.3 is the only correct value for SWV1 on Page 4. Three other combinations could be correct only if the Group judges that there is a combination of substrates on the AA, as follows:

WQV1	SWV1	Conditions
0.1	0.3	exposed oolite + peat or marl
0.1	0.5	exposed oolite + weathered oolite
0.3	0.3	peat or marl + exposed Key-stone

The remaining three combinations are explicitly indicated in the Glossary.

We also made liberal use of a refractometer, an item previously supplied to the Group, for Page 1 {"native *[should read "naturalized"]* fresh/oligohaline" and " ... seasonal high water..." boxes} and Page 2 (" ... inflow" box).

4. We red-flagged a mangrove pond in Largo Hi-Lands because a subterranean connection to nearby marine surface waters [As evidenced by the following: The pond water had high salinity for the rainy season (measured as 18 ppt); the underlying rock was Key Largo limestone (a.k.a. Key-stone), which has a structure that readily allows vertical and lateral subsurface flow;

and a mean high water mark was present on the prop roots.] allowed us to conclude, per the KEYWEP Glossary, that the AA was below seasonal high water.

The remaining items are from previously un-assessed AAs.

5. We green-flagged Lot 5/Block 6 Thompson Subdivision Section "A". The AA was hydrologically disconnected, and wetland vegetation was "precluded", per the following guidance: The AA was dominated by Schinus (USFWS wetland indicator status = FAC), with Hibiscus (FACW, should be FACU according to Pat McNeese), Borrichia (FACW or OBL), and Conocarpus (FACW+). The first two are invasive exotics, so, though the plant community is hydrophytic in the sense of the Federal JD Manual (per earlier guidance on this term), *native hydrophytes* do not predominate.

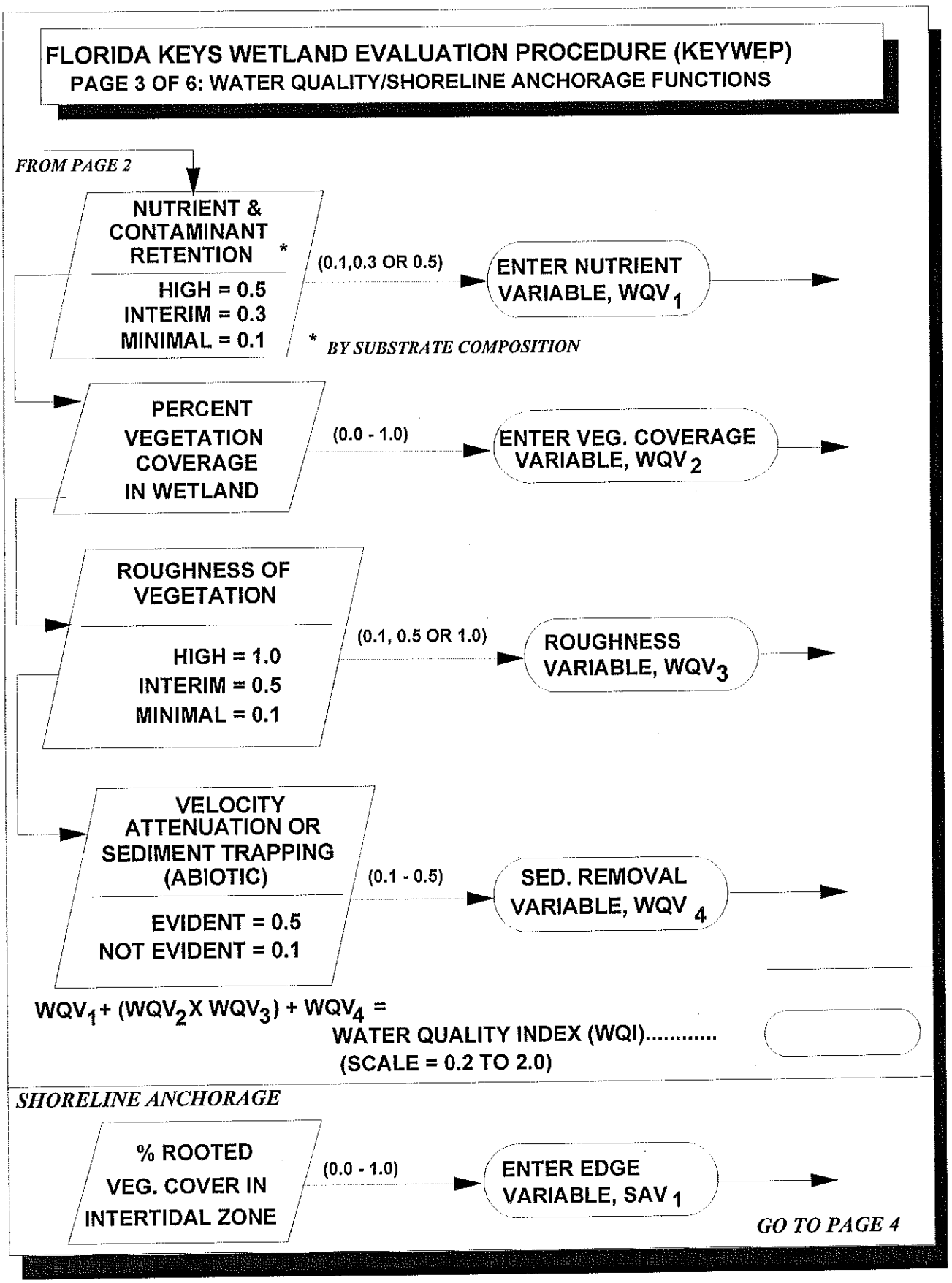
6. We concluded that Lots 27-29/Block 2 Plantation Key Colony should not be assessed. The only wetland present was in the canal shoreline setback. It was a closely mowed grassy/herbaceous area. Except for a row of mangroves at the canal, the entire site was mowed and looked like a lawn. It probably could have been green-flagged using the logic in the preceding paragraph.

7. We concluded that Lots 34-37/Block 1 Key Largo Beach was uplands. Two feet of coarse fill occurred over the area, though the vegetation could appear hydrophytic (buttonwoods) on an aerial.

8. We assessed Lots 19-20/Block 5 Buccaneer Point (FYI, it scored 3.6) and Lot 10/Blk 6 Plantation Key Colony (scored 2.55).

CC: Pat McNeese
Phil Frank
Steve Klett

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)
PAGE 3 OF 6: WATER QUALITY/SHORELINE ANCHORAGE FUNCTIONS



Nutrient & Contaminant Retention: Ability of the substrate to recycle or sequester potential pollutants by geochemical molecular processes (e.g. cation exchange) and soil bacterial metabolism.

Varies by composition of the substrate, as follows: High = peat or native marl; Interim = crushed limerock or exposed Key Largo limestone; Minimal = exposed Miami oolite.

Percent Vegetation Coverage:

Scale is as follows. Use same scale for both "wetland" (areal estimate) and "intertidal zone" (between mean water marks) in Shoreline Anchorage box (linear estimate).

	0	% =	0
1 -	19	% =	.1
20 -	39	% =	.3
40 -	59	% =	.5
60 -	79	% =	.7
80 -	99	% =	.9
	100	% =	1

NOTE: SHORELINE ANCHORAGE VARIABLE IS NOT APPLICABLE TO CLOSED WATER BODIES (THOSE WITHOUT SURFACE CONNECTION TO OPEN WATERS AT MLW). ON SUMMARY PAGE, ENTER "N/A" FOR ITS VALUE AND "0" FOR ITS SUBTOTAL.

Roughness: Ability of vegetation to slow the flow of surface water or trap and hold sediment.

Scaled by a variation on Manning's Coefficient. See accompanying discussion for derivation and examples.

Velocity Attenuation or Sediment Trapping: Decrease in the velocity of runoff or quantity of sediment suspended in that runoff.

Caused by any natural or manmade feature of the substrate that slows erosive forces or increases the rate of sedimentation. Indicators include formation of detrital lines and deposition of sediment in solution holes and microtopographic depressions.

ROUGHNESS

Derivation -- The top line below is an approximate scale for Manning's n, a coefficient of roughness used in hydrology. The middle line represents the positions of published values for various surfaces and vegetation. Keys equivalents of these vegetation types were assigned appropriate positions on the scale and grouped on the bottom line into three categories of roughness: minimal (M), interim (I), and high (H).

.01	.05	.1	.2	.3	.4	.5	.6	.7	.8
a	b		c	d	e				f
			M		I		H		

Definitions --

M = non-succulent herbs; or grasses that commonly have a sparse growth habit, e.g. Paspalum and Sporobolus. Where vegetation is distributed patchily, use within-patch density. Where vegetation is not patchy, sparse also means "scattered over entire assessment area."

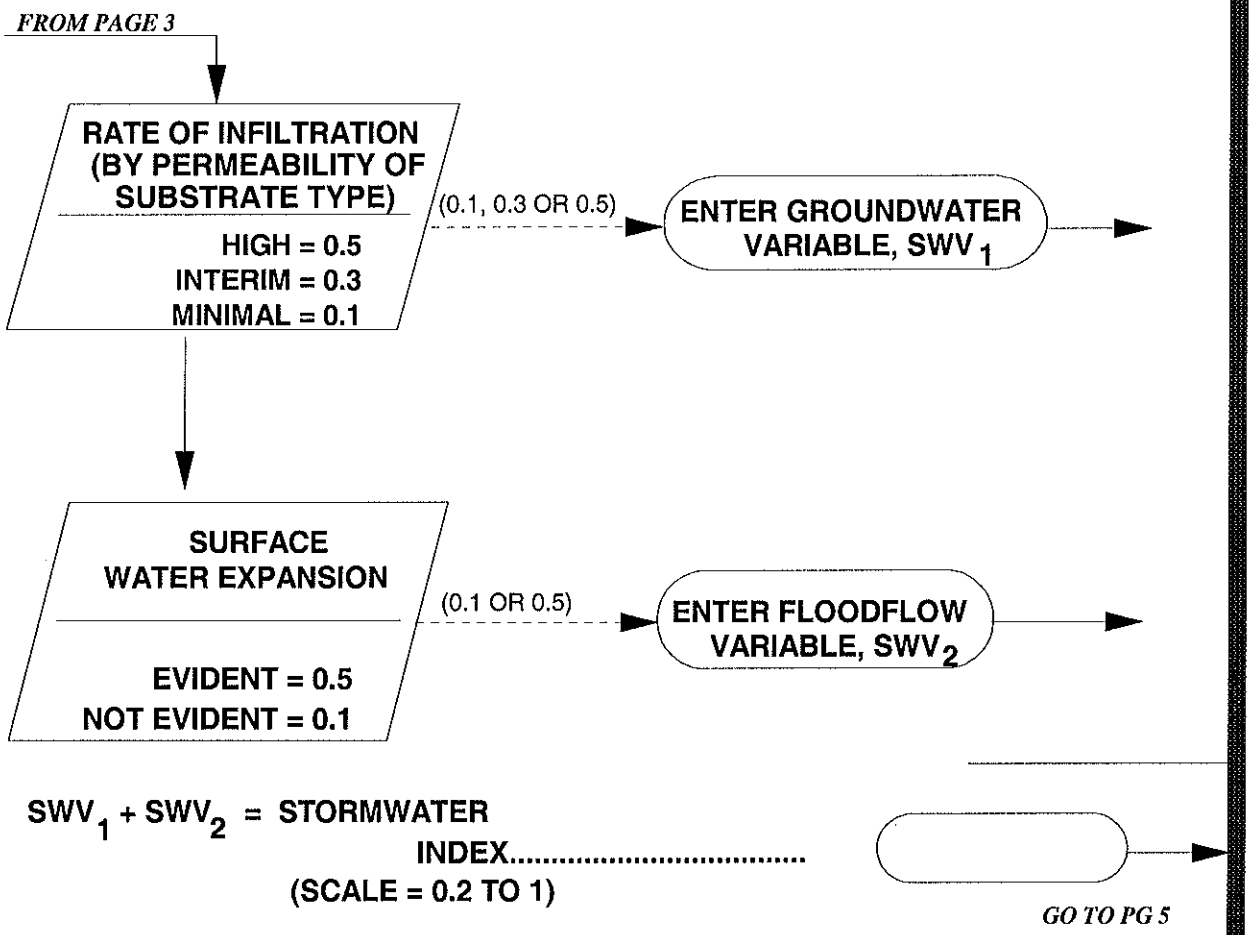
I = tuft-forming grasses e.g. Spartina; also Fimbristylis, Juncus, etc., or erect woody vegetation except as in H below.

H = succulent herbs (e.g. B. frutescens); prostrate vines (e.g. Sesuvium, Ipomea); turf-forming, non-tufted grasses (e.g Monanthochloe, Distichlis); dense (well-developed, as in a mature tree growing on a site that encourages formation of these structures) black mangrove pneumatophores; red mangrove prop roots; well-stocked buttonwood; or ground-branching shrubs.

Because obstruction of sheet flow is the phenomenon of interest, consider cover to a height of only 1 inch.

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)

PAGE 4 OF 6: STORMWATER INFILTRATION/DETENTION FUNCTIONS



Infiltration: Downward movement of surface water.

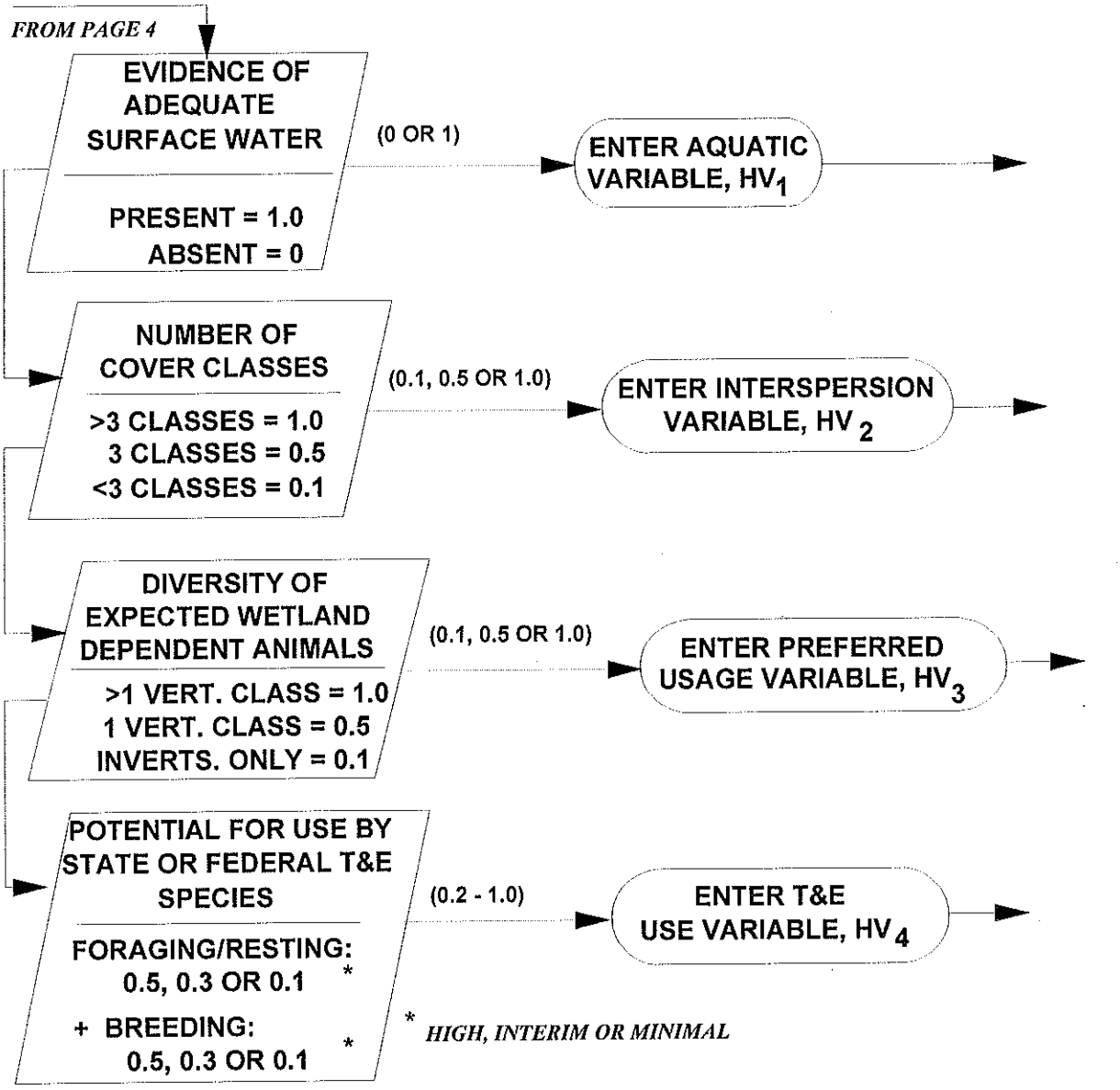
Scaled by permeability of the substrate as follows: High = exposed Key Largo limestone or weathered Miami oolite (oolite heavily fractured or containing numerous solution holes); Interim = peat or native marl; Minimal = intact oolite or compacted fill.

Surface Water Expansion: Ability to hold water on site.

Surface water expansion is an indication of the water storage capacity of the assessment wetland. There may be evidence that water stands on the AA following storm events, though it does not have permanent surface water. Indicators of surface water expansion include soil saturation and accumulation of silt on vertical surfaces.

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)
PAGE 5 OF 6: HABITAT FUNCTION

F I N A L [W/REVISIONS OF 12/4/92]



$HV_1 + HV_2 + HV_3 + HV_4 =$

HABITAT INDEX - HI.....

(SCALE = 0.4 - 4.0)

GO TO PAGE 6

Page 5 -- Habitat

Adequate Surface Water: Standing water that persists long enough to be colonized by aquatic organisms.

The potential for fish and aquatic macroinvertebrates to colonize a temporary wetland is partly a function of the duration of surface water inundation. The primary indicator of such water is the presence of fish; macroinvertebrates requiring constantly wet conditions such as fiddler crabs, marsh clams, ladder horn snails, coffee bean snails, or active or aestivating aquatic stages of insects; or relatively extensive, relatively well developed algal mats. Consensual professional judgement of the field team is required for interpretation of algal mats. Mats resume growth following dormancy after approximately 30 days of continuous inundation (source: 1994 EPA draft of interagency MFR).

Number of Cover Classes: The number of habitat types on or immediately adjoining the AA, including uplands. This contiguity is in contrast to mere proximity of habitats as viewed at the landscape scale (KEYWEP Page 6), where intervening disturbances such streets and canals may not constitute a barrier to movement of the selected animals (Page 6) across the landscape. Adjacent habitats must actually touch the AA to be included on Page 5. Habitats shall be classified from remotely sensed data, by photo-interpretation, or through consensual judgement of the field team.

Expected Wetland-dependent Animals: "Expected" means having a reasonably certain probability (in the consensual judgement of the field team) of using the AA for breeding, feeding/watering, resting, or dispersing, given knowledge of the range, distribution, vagility, and habitat requirements of the local fauna. This same knowledge is used to evaluate the potential for use by listed species (see remarks for Page 1).

Notes: (1) In practice, "1 VERT. CLASS" typically equates to *birds* being the only expected vertebrate class. (2) *Fish* are excluded from consideration.

WETLAND VEGETATIVE COVER CLASSES
FLORIDA KEYS ADVANCE IDENTIFICATION PROJECT

INTERTIDAL:

Mangrove Forest
Forests dominated by red mangroves and/or black mangroves with whites also being present; black-dominated forests often have a Batis understory; organic soils.

Scrub Mangrove
Scrub mangrove communities dominated by blacks and reds, sometimes with a cover of Salicornia or grasses; soils are a continuous cover of fine silty material deposited by low-energy tidal action; algal mats are absent.

May have to combine above class with the following class into one signature.

SUPRATIDAL:

Scrub Mangrove Salt Marsh
Scrub-mangrove dominated (> 40% trees) marsh communities with an understory of succulent herbs.

Open Salt Marsh -- Low
Herbaceous marsh with succulents (Batis, Sesuvium, Salicornia) and sometimes scattered black and white mangroves, typically with rocky or discontinuous fine soils. Algal mats may be present, sometimes as the only vegetative cover.

Open Salt Marsh -- High
Spartina- or Juncus-dominated marshes in deep fine soil, or Borrichia meadows. Note: signature may also include halophytic cover on **beache**s.

Buttonwood Salt Marsh
Buttonwood-dominated (> 40% trees) marsh ranging from those with grassy understory (e.g.Distichlis and Sporobolus) and black mangroves on thin patchy fine soil to those with thorn-woodland tree species (wild dilly, joewood, saffron plum, etc.) mixed with buttonwood on rocky or very thin organic soils.

Salt Pond
Non-vegetated (or submerged vegetation) inundated areas of brackish to saline waters; seasonal or permanent persistence.

Disturbed
Sparsely vegetated. Coarse or fine substrate. Algal mats may be present on fine substrates, sometimes as the only vegetative cover. Some **beach**es may also have this signature.

NON-TIDAL:

High Buttonwood
Buttonwood-dominated thorn woodlands with occasional salt-tolerant hammock species (blacktorch, spanish stopper, etc.); some organic soil present; tree species composition shows a marked change from the supratidal community but wetland ground covers are present. This community also colonizes disturbed nontidal wetlands.

Above class and the following class may not be jurisdictional in the Keys.

High Beach Dune
Dune communities above the spring tide line.

Freshwater Marsh
Cladium- or Fimbristylis-dominated marshes in fine and organic soils; may contain Eleocharis, Typha, red mangroves and/or white mangroves.

Freshwater Pond
Non-vegetated (or submerged vegetation) inundated areas of fresh to brackish waters (5 ppt or less for at least part of the year); seasonal or permanent persistence.

Manmade Waterbodies
Water bodies created by dredging; includes borrow pits and plugged canals.

UPLANDS:

Pinelands
Hammock (Low/High)
Exotic-dominated
Disturbed (Commercial/Industrial/Residential)
Other land use categories may be added as appropriate.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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3 February 1997

Mr. Vincent Condon
Monroe County Environmental Resources Department
2798 overseas Highway, Suite 400
Marathon, FL 33050

RE: Keys ADID functional assessment strategies

Dear Vince:

Here are my notes from EPA's last visit to the Keys. Most of the critical administrative issues were addressed in my earlier letter to Ross. These notes concentrate on technical details of the County's remaining tasks, as outlined in the recently requested grant extension. They reflect the consensus sought in Cooperative Agreements such as the grant. EPA's guidance, where requested, and offers of appropriate technical/clerical assistance are also reflected.

Day 1 A. If an assessment area (AA) looks like an acreage tract (i.e., though perhaps platted, not built-up), -assess it like an acreage tract; if it looks like a subdivision, assess it like a subdivision.

B. George Harper will attempt to get the RE#s for the subdivision AAs that have already been assessed by the field team from the Property Appraiser's office electronically. If successful, he will transfer an electronic file of subdivision, lot, block, and RE# to EPA for insertion into the Lotus worksheet. If not, Vince [or Jeanette?] must look up the RE#s and enter them onto the field summary sheets manually, for data entry by EPA. Vince will get RE#s from microfiche now for remaining subdivision AAs. George will get RE#s for the acreage tract AAs from his GIS, when they're available (i.e., when Property Appraiser's maps are imported into Growth Management's GIS -- expected winter 1997).

[C. The data will continue to be maintained by EPA as a Lotus worksheet (with ranges to be expanded), for analysis in PC-Ord by EPA and for export into ArcInfo via dBase by the County.]

D. GPS geo-referencing of fresh water holes will not be necessary. They can be fixed (and moved in the GIS) later (after the ADID), as needed. For now it is only necessary to represent the number, density, and pattern of this feature. The FMRI map can be used, supplemented with Curtis' maps where needed (as for any other AAs: Digitize holes only where FMRI does not provide a reasonably adequate approximation of number/density/pattern.).

E. George will seek help from ESRI for writing an AML to identify the FMRI buttonwood polygons (George's cover class number 3) that are adjacent to mangroves (number 1 or 2) (Those buttonwood polygons that are adjacent will be considered wetlands; those that are not adjacent, e.g. those surrounded by hammock or other uplands, and that provide a reasonably adequate approximation of Curtis' lines will be considered uplands.). If help from ESRI is not available, EPA will provide it upon George's request.

Day 2 Acreage Tract AAs and Functional Assessment

A. FMRI as surrogate for SHW: Red flag all polygons with cover class numbers 1, 2, 9, 10, 11, or 15, and all number 3s that are adjacent to a number 1 or 2.

B. FMRI as surrogate for JD: Curtis' wetland line supersedes FMRI's unless upland plant species are found to dominate the vegetational community, when inspecting a site for another purpose (In other words, special trips will not be made to ground-truth JD). Where Curtis showed uplands but FMRI showed wetlands, accept Curtis' call unless team has pre-existing local knowledge that the polygon would definitely qualify as a federally delineated wetlands

C. Ignore Curtis' upland inclusions that are less than 4 acres in size (This is the typical County minimum buildable area for a typical inclusion.).

D. Omit mapping of Curtis, thin linear wetlands along open water shorelines and in highway medians. Address these wetlands in the TSD (like the canal shorelines), but use them to join broader wetland polygons ("tongues") connected on the same shoreline by blue or black lines into one AA (if the vegetation in such tongues appears similar on an aerial, indicating similar topography and history of disturbance).

E. AAs do cross cover class boundaries, including tidal regime boundaries.

F. AA boundaries remotely demarcated for remote functional assessment will be spot-checked in the field early in the process of demarcation. If reasonably accurate, further checking, as well as revision of the procedure, will not be necessary.

G. The "conservation" red flag is to be used only during remote assessment (i.e., not in areas assessed as subdivisions). Would-be green flag sites in "conservation" red flag areas will be changed from red to green upon field inspection [or if local knowledge dictates] (Inspection would be done only if Team were in the area for another purpose.). These potential problem sites will be noted during AA demarcation.

H. Enter value for SAV, on shorelines of interior open water areas that have a significant fetch, e.g. Lake Edna, Key West Salt Ponds, Torches[, etc.?] (if the adjacent wetlands are not red-flagged.) Where running the model, use the vegetation in adjoining red flag exclusions as the vegetation for shoreline anchorage, where there is an open water body adjacent.

Day 3 Remote Assessment: Info Sources and Field Calibration

AM A. The following are sources of remotely sensed information.

NRCS County (Keys) Soil Survey FMRI map
Curtis' blue-line aerials
REDI map
ADID color infrared aerials FGFWFC Keys T&E species map CARL maps (of areas approved for acquisition)
SFWMD Save Our Rivers map (Big Pine)
USFWS Keys Refuges acquisition maps,
e.g. Key Deer Land Protection Plan

B. The following KEYWEP variables are not easy to evaluate remotely.

Page 3	Roughness
Page 3	Velocity attenuation/sediment trapping, in salt marshes
Page 4	Surface water expansion, in salt marshes
Page 5	Adequate surface water, in salt marshes

C. Therefore, the Team will run the model on site for a small representative sample (the minimum reasonable number of sites that reflect the range of local conditions, in the judgement of the team) on each key. [Small, clustered keys, e.g. some of the Saddlebunches and middle Keys, may be clustered for sampling.] Results of the field runs for the above variables will be used in remote assessment of the remainder of each key, to "calibrate" the remote assessment of those variables in place of later ground-truthing.

D. For the sake of efficiency, all remaining field work for mapping assessment areas and performing functional assessments will be done key-by-key.

IN SUMMARY, THE PROCEDURE IS AS FOLLOWS.

(i) Map AAs, (ii) run on-site sample of acreage tracts and finish subdivisions, (iii) assess remainder of acreage tracts remotely.

E. Record-keeping: Mark summary sheets of acreage tract assessments by circling "Y/N" in "sketch of acreage tract on back" line of sheet [Enter <acreage> in the "subdivision" column of the spreadsheet.]. On summary sheet, write "REMOTE" in front of the total score if an assessment was done remotely [Enter <remote> in the last six spaces of the "remarks" column of the spreadsheet.].

IT IS ESSENTIAL THAT EACH AND EVERY ASSESSMENT BE GIVEN A TOTALLY UNIQUE IDENTIFIER AS ITS "RECORD #" (CAN BE ALPHA-NUMERIC).

Day 3 PM — Acreage Tract Field Trials, Including Testing of Decisions Made on Days 2 and 3, and Other Guidance

A. Curtis's upland at the southeastern corner of Lake Edna:[is shown as a wetland class on FMRI (buttonwood adjacent to mangroves)] is an upland, except for the small, low, wet spot next to the roads. These un-mapped *small, brackish* (<< 1 acre) wet areas will be handled in the TSD.

B. HV_2:

Count cover classes adjacent to red flag AAs that are in turn adjacent (hydrologically connected, and with no geomorphic or cultural barriers to animal movement) to the polygon being assessed as themselves adjacent to the assessed polygon. In other words, red flag wetlands, by their definition, provide adjacency.

Don't count FMRI "Exotic-dominated" and "Disturbed" classes.

C. Add " .... or dense ground-branching shrubs" to the definition of "high" ("H") Roughness for Page 3.

D. Add the following definition of "acreage tract" -- large areas without construction, e.g. residential or commercial structures. (Note that scattered house sites (where "site" means the foot-print of built/filled areas on a parcel) can be excluded from acreage tracts, as uplands, in the TSD, leaving large areas for single remote assessments. (These house sites would still be potential sources of disturbance for Page 6).]

E. Pre-existing dredge spoil/fill is not, in and of itself, a (behavioral) disturbance. So, insert the word "current" into the definition of Disturbance Regime to clarify this point, thusly -- " ... by *current* domestic, .. ., or industrial activity." Pre-existing dredge spoil/fill could, however, be a conduit for animal movement that results in disturbance, such as domestic cats traveling an old fill road to hunt away from their house. Equally, past industrial activities could also preclude such disturbance, as where a canal cuts off a subdivision from a natural area.

F. At record # 2 (Lake Edna) on Grassy Key, all four problematic variables (See Day 3 AM B.) were guessed correctly beforehand (in the office prior to the field trial).

Please share this document with George Harper et al.. Thanks.

Sincerely,

Pete Kalla

THREATENED AND ENDANGERED SPECIES

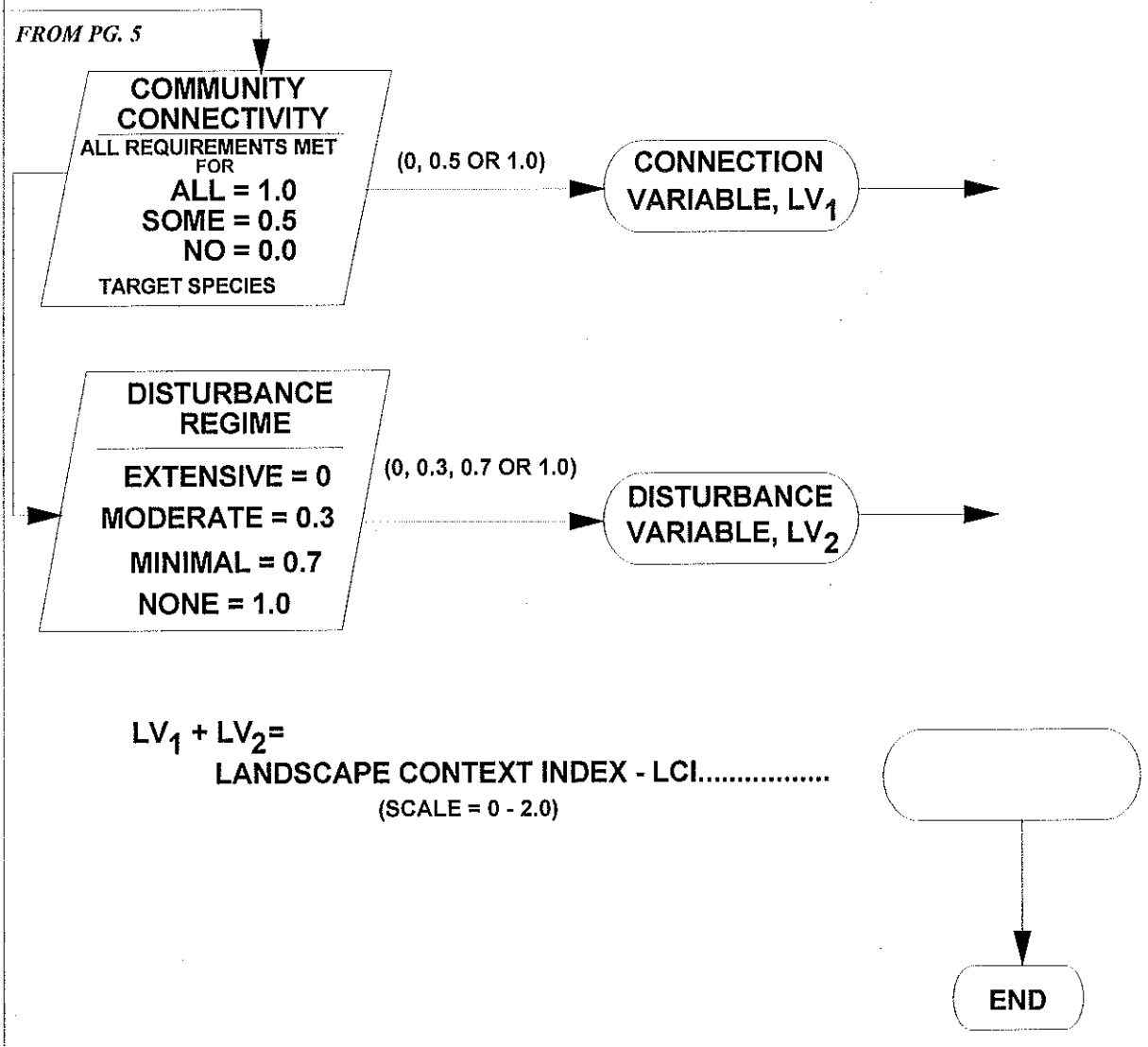
Species	Status		Utilized Wetland Habitats	
	Federal	State	Foraging/Resting	Breeding
Am. Alligator	T(S/A)	-	MF, SP, Fw	FP
Loggerhead T.	T	T	-	B
Green Turtle	E	E	-	B
Am. Crocodile	E	E	MF, SM, SP	MF, B
Ringneck Snake	-	T	FM	FM
E. Indigo "	T	T	BSM, FM	-
Key Mud Turtle	-	E	BSM, SP, Fw	FP
FL Brown Snake	-	T	FM	FM
FL Ribbon "	-	T	MF, SM, SMSM, BSM, FM	FM
Piping Plover	T	T	OSML, SP, B	-
Peregrine Falcon	T	E	OSM, SP, B, FM	-
Bald Eagle	E	T	FM, SP, B	FM
Least Tern	-	T	B	D
Key Deer	E	E	SM, OSML, BSM, Fw	-
Silver Rice Rat	E	E	MF, SMSM, OSML, BSM	BSM
LK Marsh Rabbit	E	E	OSMH, BSM, FM	OSMH, FM

T(S/A)	Listed as threatened due to similarity of appearance to American crocodile
T,E	Threatened, Endangered
MF	Mangrove Forest per "Wetland Vegetative Cover Classes" list
BSM	Buttonwood Salt Marsh "
SP	Salt Pond "
Fw	Freshwater habitats (FM or FP ")
B	Beach
SM	Scrub Mangrove "
FM,FP	Freshwater Marsh, Pond "
SMSM	Scrub Mangrove Salt Marsh "

OSML,H	Open Salt Marsh -- Low, High	"
OSM	Open Salt Marsh habitats (OSML or OSMH	")
D	Disturbed	"

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)

PAGE 6 OF 6: LANDSCAPE EFFECTS ON HABITAT



Community Connectivity: The extent to which the AA is an accessible part of the native ecosystem.

Scaled by the proportion of a target group of species for which the AA and its accessible surroundings provide all critical life history requirements. For KEYWEP, requirements consist of cover classes and minimum area or typical home range size. Habitat on the AA need not be high quality; it need only match the surounding cover class. Surroundings are accessible if there are no intervening physical or behavioral barriers to animal movement. On the accompanying list a group of target species is given for each of the three broadly defined (by plant species composition and physiognomy) wetland categories in the Keys. These particular animals were selected because they preferentially inhabit intact native landscapes and because their life history requirements are sufficiently well known.

Disturbance Regime: The degree to which natality and mortality of the target species are adversely affected by domestic, recreational, commercial, or industrial activity.

These effects are caused by behavioral changes due to competitive displacement by humans and predation or resource competition by human commensals. Such impacts stand in contrast to direct, physical habitat destruction or degradation by development. Due to their geography, the bridged Keys have a certain background level of disturbance even in the remote areas of these Keys. This level is designated as "NONE" for KEYWEP. Many unbridged Keys are also subjected to disturbance.

TARGET SPECIES FOR COMMUNITY CONNECTIVITY

Use all habitats that apply.

Mangroves[1]

Lower Keys	Middle/Upper Keys
mangrove cuckoo[2]	mangrove cuckoo[2]
prairie warbler[3]	prairie warbler[4]
Key deer[5,7]	Am. crocodile[6]

Low Open Salt Marsh/Buttonwood Salt Marsh

Lower Keys	Middle/Upper Keys
silver rice rat[7]	prairie warbler
Key deer	E. indigo snake[7]

High Open Salt Marsh/Freshwater Marsh

Lower Keys	Middle/Upper Keys
marsh rabbit[8]	marsh rabbit[8]
Key deer	E. indigo snake

[1] not applicable to strips along edges of canals and borrow pits
[2] forest (per Cover Class list) + hardwood hammock (closed canopy)
[3] scrub class + forest class + undisturbed buttonwood salt marsh
[4] as in [3] immediately above. Do not use on North Key Largo.
[5] scrub
[6] scrub + forest. Use only on North Key Largo.
[7] use habitat supplement.
[8] high open salt marsh + freshwater marsh + buttonwood salt marsh

ESTIMATES OF MINIMUM AREA OR HOME RANGE

Mangrove cuckoo = 30 ac. (total of habitats in [2])
Prairie warbler = 3 ac. (tall, dense scrub) - 5 ac. (as in [3])
Key deer = 100 ac. (total of various wetland and upland habitats)
Am. crocodile = 100 ac. (includes salt ponds)
Silver rice rat = 50 ac. (includes mangroves and low hammock).
E. indigo snake = 100 ac. (total wetlands and uplands)

Marsh rabbit = 3 ac. [core habitat (open grasses)] - 10 ac. (total)

ADDITIONAL SOURCES OF HABITAT USE AND MINIMUM AREA OR HOME RANGE INFORMATION

Forys, E. 1993. Biology of the lower Keys marsh rabbit at navy lands in the lower Florida Keys. Semi-ann. Performance Rept. no. 4. Florida Game and Fresh Water Fish Commission, Tallahassee. 51 pp.

Hoffman, W. Personal communication to P. Kalla, 24 March 1993. [prairie warbler]

Jacobson, T. 1983. Crocodilians and islands: status of the American alligator and American crocodile in the lower Florida Keys. Fla. Fld. Nat. 11:1-24.

Klimstra, Silvy, and others. Various papers and reports on Key deer.

Kushlan and Mazzotti. Various papers and reports on the American crocodile in Everglades National Park.

Moler, P. Unpublished data on Eastern indigo snakes in mainland south Florida.

Spitzer, N. 1983. Aspects of the biology of the silver rice rat. M.S. Thesis, Univ. of Rhode Is., Kingston. 100pp.

Strong, A., and T. Bancroft. Patterns of deforestation and fragmentation of mangrove and deciduous seasonal forests in the upper Florida Keys. Bull. Marine Sci. (in review). [mangrove cuckoo]

Wilmers, T. Personal communication to P. Kalla, 25 March 1993. [Key deer]

ADDITIONAL GUIDANCE ON COMMUNITY CONNECTIVITY

Corridors must be of same habitat as those listed in the Glossary.

Minimum areas and home ranges must *not* be "linearized" to enable a connection. Generally, corridors must be at least 30 m wide (approximately) for most target species. Prairie warblers will move easily in narrower corridors.

Ask, "Is the AA an accessible piece of a larger polygon?"

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)
FIELD SUMMARY PAGE

RECORD #
EVALUATION TEAM:
DATE: TIME:
ISLAND:
SUBDIVISION NAME:
SUBDIVISION LOT/BLK NOS._____/_____

CLASSIFICATION:

WATER SOURCES/SINKS:
INFLOW(S):

OUTFLOW(S):

SKETCH OF ACREAGE TRACT LOCATION ON BACK: Y/N
FLAG? RED CODE_____ GREEN_____
RECENT RAIN/TIDAL EVENTS:

SALINITY:
SUBSTRATE TYPE:

VARIABLE		VALUE	SUBTOTALS
PAGE 3 - WATER QUALITY ENHANCEMENT:			
NUTRIENT VARIABLE (WQV_1)	(0.1, 0.3 OR 0.5) →		
% VEG. IN WETLAND (WQV_2)	(0 - 1.0) →	+	
ROUGHNESS (WQV_3)	(0.1, 0.5 OR 1.0) → X		
SEDIMENT REMOVAL (WQV_4)	(0.1 OR 0.5) →	+	= +
SHORELINE ANCHORAGE:			
% VEGETATED EDGE (SAV_1)	(0 - 1.0) →		= +
PAGE 4 - STORM WATER INFILTRATION/DETENTION:			
INFILTRATION (SWV_1)	(0.1, 0.3 OR 0.5) →		
SURFACE WATER EXPANSION (SWV_2)	(0.1 OR 0.5) →	+	= +
PAGE 5 - HABITAT INDEX:			
SURFACE WATER PRESENT (HV_1)	(0 OR 1) →		
HABITAT COVER TYPES (HV_2)	(0.1, 0.5 OR 1) →	+	
WETLAND-DEPENDENT USE DIVERSITY (HV_3)	(0.1, 0.5 OR 1) →	+	
T&E USE -FORAGING/RESTING	(0.1, 0.3 OR 0.5) →	+	
T&E USE -BREEDING	(HV_4) (0.1, 0.3 OR 0.5) →	+	= +
PAGE 6 - LANDSCAPE CONTEXT:			
COMMUNITY CONNECTIVITY (LV_1)	(O, 0.5 OR 1.0) →		
DISTURBANCE REGIME (LV_2)	(0, 0.3, 0.7 OR 1) →	+	=

(0.8 - 10) **TOTAL FUNCTIONAL INDEX** =

L = Local impact of fill, local impact on function
G = Global impact of fill, global effect on function

FLORIDA KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)
FIELD SUMMARY PAGE

RECORD #
EVALUATION TEAM:
DATE: TIME:
ISLAND:
SUBDIVISION NAME:
SUBDIVISION LOT/BLK NOS._____/_____

SKETCH OF ACREAGE TRACT LOCATION ON BACK: Y/N
FLAG? RED CODE_____ GREEN_____
RECENT RAIN/TIDAL EVENTS:

CLASSIFICATION:

WATER SOURCES/SINKS:
INFLOW(S):

OUTFLOW(S):

SALINITY:
SUBSTRATE TYPE:

	VARIABLE		VALUE	SUBTOTALS
	PAGE 3 - WATER QUALITY ENHANCEMENT:			
L	NUTRIENT VARIABLE (WQV_1)	(0.1, 0.3 OR 0.5) →		
L	% VEG. IN WETLAND (WQV_2)	(0 - 1.0) →	+	
L	ROUGHNESS (WQV_3)	(0.1, 0.5 OR 1.0) → X		
L	SEDIMENT REMOVAL (WQV_4)	(0.1 OR 0.5) →	+	= +
	SHORELINE ANCHORAGE:			
G	% VEGETATED EDGE (SAV_1)	(0 - 1.0) →		= +
	PAGE 4 - STORM WATER INFILTRATION/DETENTION:			
L	INFILTRATION (SWV_1)	(0.1, 0.3 OR 0.5) →		
L	SURFACE WATER EXPANSION (SWV_2)	(0.1 OR 0.5) →	+	= +
	PAGE 5 - HABITAT INDEX:			
L	SURFACE WATER PRESENT (HV_1)	(0 OR 1) →		
G	HABITAT COVER TYPES (HV_2)	(0.1, 0.5 OR 1) →	+	
G	WETLAND-DEPENDENT USE DIVERSITY (HV_3)	(0.1, 0.5 OR 1) →	+	
G	T&E USE -FORGING/RESTING	(0.1, 0.3 OR 0.5) →	+	
G	T&E USE -BREEDING } HV_4	(0.1, 0.3 OR 0.5) →	+	= +
	PAGE 6 - LANDSCAPE CONTEXT:			
G	COMMUNITY CONNECTIVITY (LV_1)	(O, 0.5 OR 1.0) →		
G	DISTURBANCE REGIME (LV_2)	(0, 0.3, 0.7 OR 1) →	+	=

(0.8 - 9.8) **TOTAL FUNCTIONAL INDEX** =

L = Assess only on parcel only if defensible and documented
G = Never assess on area smaller than entire AA

APPENDIX I: KEYWEP RATIONALE

KEYS WETLAND EVALUATION PROCEDURE (KEYWEP)

Development of the KEYWEP Functional Assessment

The application of wetland functional assessments in the Federal permitting process is fairly widespread, but it was rare in the Florida Keys prior to the ADID project. At the time the ADID was initiated, the best known Federal procedures were the Wetland Evaluation Technique (Adamus et al., 1987) and the Habitat Evaluation Procedure (USFWS, 1980). These models were examined and quickly rejected as possible candidates for Keys wetlands evaluation, mainly due to their focus on watershed functions, inapplicable wetland categories and other factors. The location of Keys wetlands in a low-lying oceanic island ecosystem make them uniquely different from typical mainland wetland systems. Although Keys wetlands serve the same general functions as mainland wetlands, the way in which those functions operate is very different, making their evaluation impossible by existing mainland methodologies (see rationale below). Therefore, it was decided that a new wetlands evaluation procedure specific to the Florida Keys would be developed. For this task an interagency team was formed. The team included experts in functional assessment from EPA and COE's WES, and experts in local wildlife and plant ecology from FGFWFC and County staff. It was decided that as a practical tool the new procedure should:

- provide a quick but comprehensive tool for field application,
- require little or no data collection or in-depth field analysis,
- give consistent results among different users,
- incorporate best professional judgement,
- be easily conducted by one or more persons in the field,
- evaluate and give appropriate weighting to various Keys wetlands functions, and,
- stand up to peer and agency review.

After many weeks of field work and several draft documents, the final version of KEYWEP was ready for use. It met all of the criteria listed above and provided a comprehensive assessment technique for all Keys wetlands encountered. It took into account differences between the Upper and Lower Keys and evaluated wetlands in both an inherent and landscape functional context. Continuity in application of KEYWEP over the entire length of the project was maintained by continued involvement and written guidance provided by key personnel from EPA, assisted by present and former staff of Monroe County. The model is expected to be a valuable tool in the future and can be considered one of the most useful products of the ADID project. KEYWEP is recommended over any other assessment method for use in the Keys because it was developed specifically for the Keys in a scientifically rigorous manner.

General KEYWEP Rationale

A discussion of the rationale of individual KEYWEP variables must be preceded by further discussion of the KEYWEP development process. As mentioned above, the KEYWEP had to be a practical field tool while at the same time providing good evaluation and appropriate weighting to various Florida Keys wetland functions. The KEYWEP development team first had to describe the functions of various types of Keys wetlands in general terms. Generic wetland functions are related to two main issues: how wetlands affect water (collection, release, purification, storage, etc.) and support the ecological community (assemblage of plants and animals) created by the presence of the wetland. From these issues, three main categories of wetland functions were derived: water quality, water storage, and habitat. These three categories were all deemed appropriate for Keys wetlands, so the team moved ahead to define specific functions for each of these categories. Table 4 summarizes the progression from general to specific functions. Definitions for KEYWEP functions were included in the field package for reference purposes. They are:

Sediment Removal:	Filtration of suspended solids from runoff generated by rain events.
Toxicant Sequestration:	Storage of heavy metals and toxic organics in sediment and woody vegetation.
Nutrient Removal:	Uptake of soluble forms of nutrients by plants, and binding of phosphates (PO_4) in carbonaceous substrates.
Shoreline Anchorage:	Dissipation of wave energy, prevention of direct contact between moving water and the soil surface, and stabilization of the shoreline profile by vegetation.
Stormwater Infiltration:	Downward movement of direct precipitation or storm runoff into the soil or bedrock.
Stormwater Detention:	Increase in the time elapsed between a storm event and the subsequent entry of runoff into inshore/nearshore surface waters.
Habitat Provision:	Support of animal populations by furnishing escape or resting cover, nesting substrates, or foraging sites.

Table 4. Wetland functions considered during the development of the Florida Keys Wetland Evaluation Procedure (KEYWEP).

General Functions (summarized in KEYWEP)	**EPA-Listed Functions for ADIDs** (USEPA, 1989, Appendix 5)	**KEYWEP** (as evaluated in KEYWEP)
Water Storage		
(Stormwater Infiltration)	flood water storage	surface water expansion
(Stormwater Detention)	surface water and groundwater connections	rate of infiltration
	flooding reduction	
Water Quality		
(Sediment Removal)	sediment retention	velocity attenuation/sediment trapping
(Toxicant Sequestration)	water purification and enhancement	vegetative cover and roughness
(Nutrient Removal)	nutrient retention and removal	nutrient and contaminant retention
(Shoreline Anchorage)	erosion control	intertidal shoreline anchorage
Habitat		
(Habitat Provision)	food chain support	evidence of adequate surface water
		diversity of expected wetland animals
	fishery and wildlife habitats	used for breeding by Federally listed animals
		native freshwater/oligohaline
		number of vegetative cover classes
		potential use by Federal/State listed animals
		community connectivity
		disturbance regime
	migratory waterfowl usage	
	recreation	
	heritage values	approved purchase for conservation

The most noticeable feature of the KEYWEP is its emphasis on habitat functions. Team consensus early on in the development of the model supported the higher weighting of habitat functions over hydrological and water quality functions for two main reasons. First, as previously mentioned, the Florida Keys do not by virtue of their size, topography and geology exhibit significant watershed functions. Second, the Florida Keys, again because of their unique features (island isolation and Caribbean floral component) serve as exceptional wildlife habitat for migratory birds and for several threatened and endangered animals and plants. Although not all of these species are exclusive wetland dwellers, most of them depend on some type of wetlands at some time in their life history. The rationale for each individual attribute evaluated in the procedure clarifies and supports the distribution and weighting of sub-scores assigned for each function. One notable feature of KEYWEP is the way the scoring range is set up. Every wetland is considered to have some level of functional value and therefore is awarded a score comparable on a sliding scale to other wetlands. No wetland receives a score of zero (0) indicating "no functional value." The possible total score ranges from 0.8 to 9.8; the lowest possible scores for water quality, hydrological and habitat functions are 0.2, 0.2, and 0.4, respectively. The purpose of this feature in KEYWEP is to show that all wetlands are considered to have some level of functionality. As discussed below, KEYWEP scoring criteria are generally applied to vegetated wetlands. The fact that they are jurisdictional implies that they receive some level of regular inundation or saturation. Therefore, all wetlands perform beneficial water quality, stormwater, and habitat function to some degree.

Interagency Team Approach

KEYWEP assessments were done by an intergovernmental team, both in the field and remotely using aerial photographs and other information. The three-person team consisted of a Federal biologist, a State biologist and a Monroe County biologist. The participating Federal and State agencies, FWS and GFC, signed cooperative agreements with EPA to participate. Both agencies received copies of the finished GIS mapping products as part of the agreement. The field team's work was organized and scheduled for both field and remote assessments by the Monroe County biologist, working systematically through the prioritized areas of the Keys. Field assessments were performed mainly in subdivision areas, as expected. No improved subdivisions were assessed remotely. Remote assessments were generally performed on acreage tracts, with limited ground-truthing.
For remote assessments, the team used various sources of existing information including the following:

FMRI Land Use Maps
Advisory Wetland Jurisdictional Maps
Monroe County Property Appraiser's Strip Maps
NASA infrared aerial photographs
"Redi-Map" real estate aerial photographs
Florida Department of Transportation aerial photographs
Monroe County Threatened and Endangered Animal Species Maps
Florida Conservation and Recreational Lands Acquisition Program Maps
South Florida Water Management District's Save Our Rivers Acquisition Program Maps
Folk et al. (1991) Key Deer Habitat Map Set
U.S. Fish and Wildlife Service Refuge Acquisition Maps
Monroe County Land Authority Acquisition Maps

KEYWEP Assessment Areas

Before applying KEYWEP, a given wetland area to be assessed must be demarcated. This area is called the assessment area (AA). The AA is defined in KEYWEP as "all adjoining wetlands that are driven by the same common shared hydrologic regime." A wetland is evaluated in part based on its ability to handle incoming and outgoing water. The resulting characteristics of that wetland then define its ability to provide the basic physical and biological components necessary for a quality habitat. Therefore, KEYWEP must apply to an area that is defined hydrologically, including all of the different vegetation communities encompassed. Guidance for determination of an AA is given in KEYWEP as follows:

> "The AA is delineated by identifying physical points of hydrologic change including natural or manmade barriers and points where the gradient changes rapidly. Water exchange may take place daily, seasonally, or anywhere in between but it must be evidently regular. Storm-driven connection obviously does not count as exchange. Where a barrier is present in such a way that it is evident that two wetlands are not regularly connected by hydrologic interaction, then they should be assessed as two separate AAs. In the Keys the primary exchange of water is tidal. Ponds, sloughs, and other depressional wetlands may have a ground water component to their hydrology. Obvious gradient changes to areas above the seasonal high water line (nontidal vegetative communities) will usually define the landward edge of the AA. For the purposes of this assessment, the seasonal low water line will be used as the surface water wetland boundary for wetlands bordering canals or open oceanic or gulf waters.
>
> The AA for a small wetland will be easily identified. Where there are ponds or sloughs present, these water bodies are included in the assessment area.
>
> The AA for a large wetland will be more difficult to identify and may require use of aerial photography. It may be necessary to sample several subsets of these AAs.
>
> As indicated by the definition of AA and the sub-models for flagged areas, an AA can contain red flags but not green flags [defined in a later section]. It is intended that KEYWEP be run on an AA containing red flags as if they were part of that AA."

The first paragraph of the above discussion shows that KEYWEP was developed with the hydrogeomorphic (HGM) system of wetland classification, then under development by Brinson (1993), in mind. As described later in this chapter, in KEYWEP wetland functional indices are scored relative to the best attainable local condition. Thus KEYWEP was also a precursor to the HGM assessment models (Smith et al., 1995) now being developed by WES and EPA.

It should be noted that fringing wetlands along canals adjacent to upland subdivision lots were included in the jurisdictional mapping process (Kruer, 1995). These narrow fringes have recognized functional value but were of lower priority than wetland lots. KEYWEP is designed to assess these fringes and may be used in the field for this purpose in the future. For the ADID, KEYWEP was used to assess some of them remotely as described in a later section.

KEYWEP Habitat Classifications

As previously mentioned the habitat classifications used for KEYWEP differ from those used for the Land Use mapping (see Table 3). A modified version had to be developed for the mapping due to limitations in ability to interpret aerial photographs. However, it was decided that the original habitat types developed for KEYWEP were still appropriate for use in the field. The habitat classifications described in KEYWEP are displayed in the box on the following page (and in Figure 22). The scheme was based on that developed by Kruer (1991) for local wetland systems.

As was the situation with several aspects of KEYWEP and the entire ADID project, this classification scheme had to be developed largely based on local knowledge and experience and could not be modeled after known classification systems in use for Florida or elsewhere. Freshwater wetlands, for example, illustrate the point that local interpretation was a major factor in characterizing habitats. Kruer (1991) wrote, " For the purposes of defining 'freshwater' I've used 5 ppt as the cut-off point...Cowardin (1979) uses 0.5 ppt as the cut-off, much too low to be used locally. Just about all waters in the Keys have more salt than this due to the surrounding environment, and animals (deer, raccoons, rodents, birds, etc.) are adapted to ... higher levels of salt than on the mainland." This local approach also allowed use of a more detailed and refined habitat list for field assessments. For example the differences between "Scrub Mangrove" and "Scrub Mangrove Salt Marsh" are subtle to non-existent for mapping purposes but they become significant for wetland functional assessment purposes.

KEYWEP Habitat Classifications

Intertidal

Mangrove Forest: Forests dominated by red mangroves and/or black mangroves, with white mangroves also present; black-dominated forests often have a *Batis* understory (see Figure 7); organic soils.

Scrub Mangrove: Scrub mangrove communities dominated by red and black mangroves, sometimes with a cover of *Salicornia* or grasses; soils are a continuous cover of fine silty material deposited by low-energy tidal action; algal mats are absent.

Supratidal

Scrub Mangrove Salt Marsh: Scrub-mangrove dominated (> 40% trees) marsh communities with an understory of succulent herbs.

Open Salt Marsh - Low: Herbaceous marsh with succulents (*Batis*, *Sesuvium*, *Salicornia*) and sometimes scattered black and white mangroves, typically with rocky or discontinuous fine soils. Algal mats may be present, sometimes as the only vegetative cover.

Open Salt Marsh - High: *Spartina*- or *Juncus*-dominated marshes in deep fine soil.

Buttonwood Salt Marsh: Buttonwood-dominated (> 40% trees) marsh ranging from those with grassy understory (e.g., *Distichlis* and *Sporobolus*) and black mangroves on thin patchy fine soil to those with thorn woodland tree species (wild dilly, joewood, saffron plum, etc.) mixed with buttonwood on rocky or very thin organic soils.

Salt Pond: Non-vegetated (or submerged vegetation) inundated areas of brackish to saline waters; seasonal or permanent persistence.

Disturbed: Sparsely vegetated. Coarse or fine substrate. Algal mats may be present on fine substrates sometimes as the only vegetative cover.

Nontidal

High Buttonwood: Thorn woodlands with buttonwoods and occasional salt-tolerant hammock species (blacktorch, spanish stopper, etc.); some organic soil present; tree species composition shows a marked change from the supratidal community, but wetland ground covers are present. This community also colonizes disturbed nontidal wetlands. As a class it may not be jurisdictional in the Keys.

High Beach Dune: Dune communities above the spring tide line. This class may not be jurisdictional in the Keys.

Freshwater Marsh: *Cladium*- or *Fimbristylis*-dominated marshes in fine and organic soils; may contain *Eleocharis*, *Typha*, red mangroves and/or white mangroves.

Freshwater Pond: Non-vegetated (or submerged vegetation) inundated areas of fresh to brackish waters (5 ppt or less for at least part of the year); seasonal or permanent persistence.

Manmade Waterbodies: Water bodies created by dredging; includes borrow pits and plugged canals.

Upland

slash pinelands, exotics-dominated, hardwood hammock, disturbed (commercial/industrial/residential)

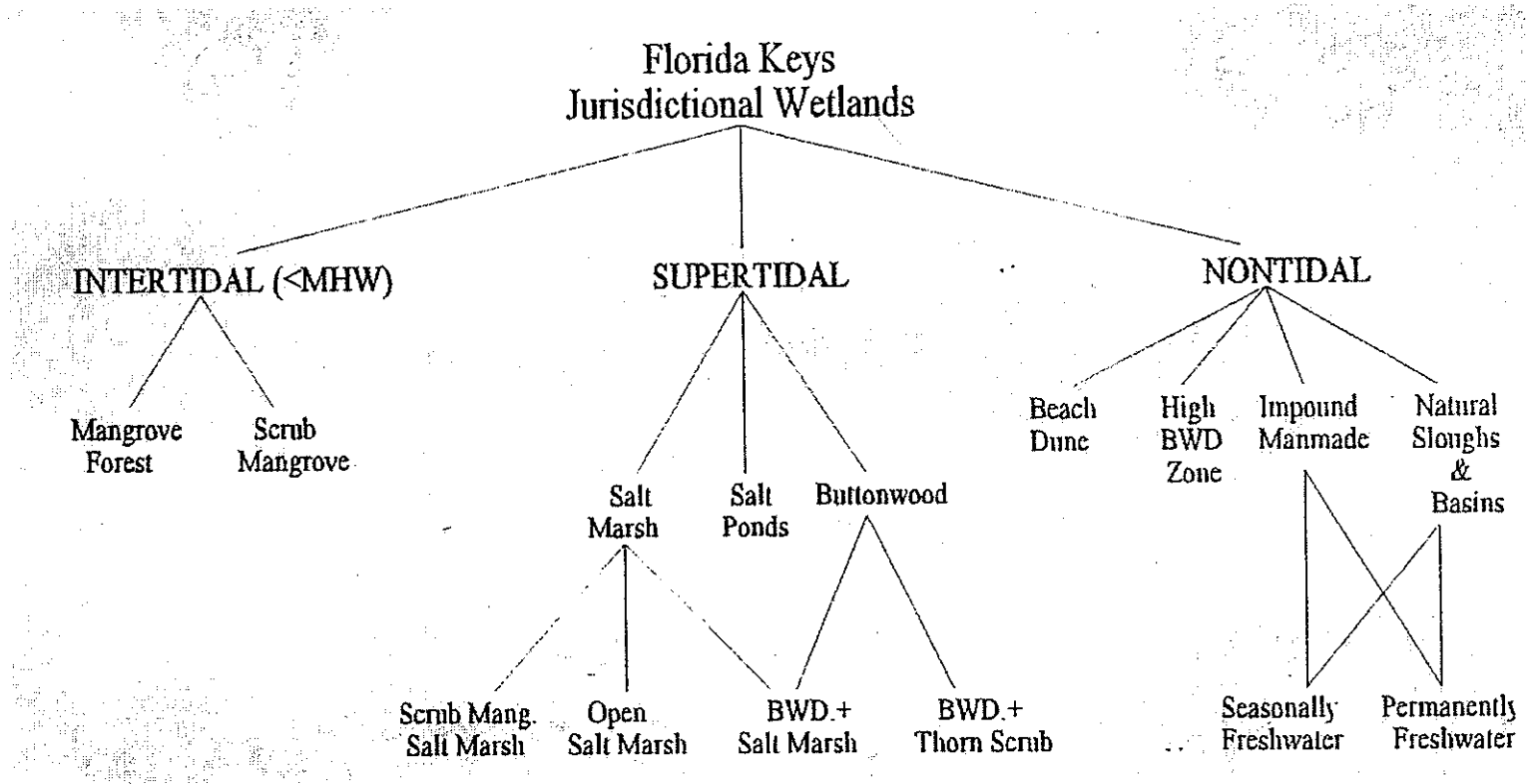


Figure 22. Vegetation classification scheme for Florida Keys wetlands.

Red Flag Wetlands

In KEYWEP a wetland is first evaluated with respect to listed red flag and green flag categories. If the AA is not automatically classified as a red or green flag wetland, one continues through the model. The primary purpose of this preliminary exercise is to avoid the expenditure of significant resources on the assessment of wetlands with obvious exceptionally high or low value. In the ADID this technique was used more extensively for red flags (highly functional wetlands) than for green flags (see discussion of green flags below), due to the rarity of green flag wetlands. Red flag wetlands were those that clearly exhibited a high level of integrity in soils, hydrology, community structure, size, landscape position and other features. These wetlands were assumed in the model to have the highest functional capacity in the Keys based upon existing literature and best professional judgement. Tidal mangrove forests are an excellent example. As discussed earlier, the value of this wetland class was well documented prior to the ADID. That documentation led to the prior implementation of protective measures at all levels of government. Therefore, it was not necessary or practical to allocate resources toward field assessment of tidal mangrove wetlands. Definitions and rationales for each red flag category follow below. Figure 23 shows the field sheet used to determine red flags.

Approved Purchase for Conservation (CONS)
This red flag includes wetlands owned or approved for purchase from a willing seller by any public or private entity for the primary purpose of conservation. Permanently impacted (see below) wetlands adjacent to an undisturbed upland purchase are excluded from this definition.

The list of conservation entities includes, but is not limited to, U.S. FWS, DEP State Lands, Conservation and Recreation Lands (CARL) program, Preservation 2000, South Florida Water Management District Save Our Rivers Program, The Nature Conservancy (TNC), the Trust for Public Lands, and the Florida Keys Land and Sea Trust. If only part of an assessment area is an "approved purchase for conservation", that portion is automatically a red flag.

Method: The field team was able to use narrative and graphic parcel information from the various acquisition agencies listed above to determine what lands fell into this category. Since acquisition lists change (usually with the addition of parcels), the status of any given parcel may be different if and when KEYWEP is applied to it in the future. The team's main purpose in identifying acquisition parcels for the ADID was, again, to avoid carrying out unnecessary field assessments at these sites. To ensure that only wetlands of high functionality are included in this particular red flag category, "permanently impacted" wetlands are excluded from consideration (see

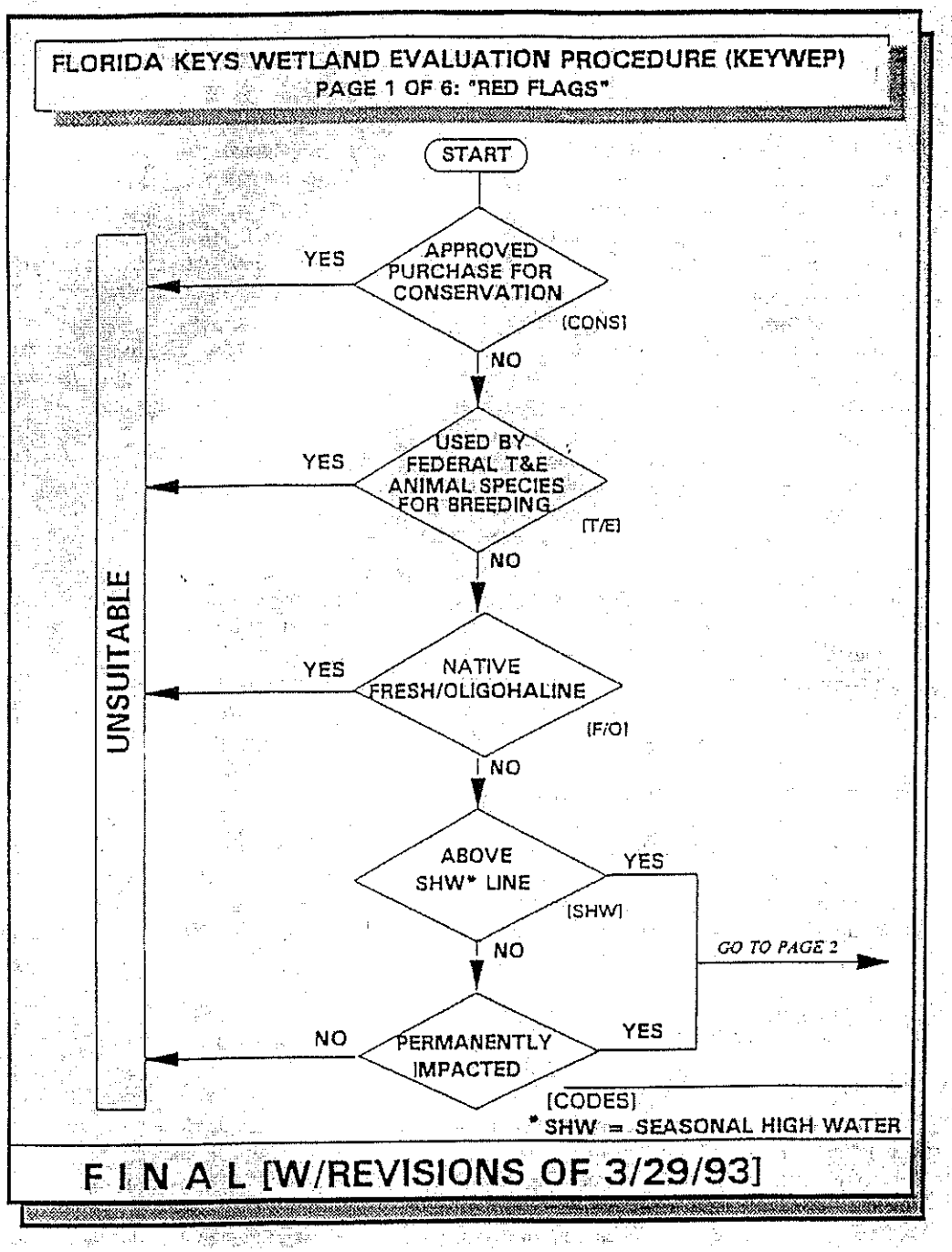


Figure 23. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Red Flags" field assessment sheet.

explanation of "permanently impacted" below). Permanently impacted wetlands, especially within subdivisions, are rarely located within acquisition boundaries. The field team was allowed to use best professional judgement to decide whether to apply the model in a subdivision located within an acquisition area. Improved subdivision lots are usually the most expensive and most time-consuming purchases, and the expectation of development is much greater there than in natural areas. Therefore, the field team generally did not designate this red flag in the few instances where subdivisions fell within acquisition boundaries.

The "willing seller" component of this red flag did not enter into the assessment immediately. The red-flagging of a wetland under KEYWEP only becomes significant when some action regarding the parcel is taken (owner- or agency-initiated inquiry, application for development, negotiation for purchase, etc.). At that time the ownership and willingness of the owner to sell the land for conservation becomes important. For ADID purposes, the subject parcel was mapped as a red flag with the assumption that the flag may be removed in the future. In other words, all owners were assumed to be "willing sellers" pending receipt of information to the contrary. Since red-flagging portions of an AA does not affect the score of the remaining non-red flag portion, this approach was deemed acceptable.

Rationale: The Florida Keys are a truly unique tropical ecosystem within the continental United States. This has long been recognized on local, state and national levels as evidenced by the early and continued efforts to establish refuges, sanctuaries and parks (see earlier discussion). Associated with these efforts are several established land acquisition programs which sustain varying levels of activity at any given time. As seen by the list of primary participants above, acquisition is proceeding on several levels of government and in the private sector as well. The motivating factors behind the purchase of property for conservation are:

- to preserve highly functional ecosystems,
- to preserve specific plant and animal species or species assemblages, and,
- to preserve archeological or historical resources.

Wetlands acquisition is most often linked with purchase of larger systems that include other rare and unique habitats such as hardwood hammocks and slash pinelands. These less protected upland habitats are often the primary motivator in the procurement of acquisition funds. The result is purchase of wetlands that are highly functional parts of larger ecosystems. Every wetland listed for acquisition for "conservation purposes" is justified for that listing based on high functionality (each function is discussed in further detail in the model). The context of that functionality is usually expressed relative to the particular program goals of the acquiring entity. For example, acquisition by the FWS National Key Deer Refuge is carried out in accordance with program goals geared towards Federal endangered species recovery and management (USFWS, 1991). The Upper Keys portion of the "Florida Keys Ecosystems" CARL project was originally based on the demonstrated Keys-wide ecosystem relationships of large upland/wetland parcels (National Audubon Society et al., 1990). The Nature Conservancy (1989) also documented the rationale for purchase of several uplands and wetlands for conservation. Because the primary driving force behind acquisition efforts in the Keys is to preserve remaining undisturbed habitat, those parcels listed for acquisition are already documented as having very high functionality. This pre-existing information is the primary rationale for designating these wetlands as red flags.

Used by Federal Threatened or Endangered Animal Species for Breeding (T/E)
This red flag category applies to any animal designated as threatened or endangered according to the most recent listing of the U.S. Fish and Wildlife Service. Use of a wetland area by any such animal shall be evident by documented record on file with any local, State, or Federal agency or other recognized repository of biological field information, such as the National Audubon Ornithological Research Unit, the Nature Conservancy Florida Keys Field

Office, or the Florida Keys Audubon Chapter, or by strong physical evidence of presence (e.g. droppings, prints, nest, or shed skin).

Method: The State and Federal threatened and endangered animal species listed at the time the ADID assessment was conducted are shown in Table 5. The team intersected known ranges and sitings of these animals with known habitat requirements and land cover to determine breeding use. The presence of State and Federal wildlife biologists on the field team greatly enhanced the efficiency and reliability of this and other habitat variables evaluated.

Rationale: As seen in Table 5, there are four threatened and six endangered species listed at the Federal level that breed in the Keys. The sea turtles use sandy beach habitat exclusively for nesting. The Eastern indigo snake (*Drymarchon corais couperi*) and the Key deer use primarily uplands for breeding purposes. The remaining five species use wetland habitat for breeding and nesting. The two threatened species, *Alligator mississippiensis* (American alligator) and *Haliaeetus leucocephalus* (bald eagle) breed in freshwater wetlands. The eagle also uses mangrove forests for nesting. The two endangered mammals on the list, *Oryzomys argentatus* (silver rice rat) and *Sylvilagus palustris hefneri* (Lower Keys marsh rabbit) are very specific to low salt marsh and high salt marsh/freshwater marsh, respectively, for breeding. The American crocodile uses mangrove wetlands for breeding and nesting. The rationale behind red-flagging the wetland breeding habitats of these five species in the Keys is based on several factors:

Table 5. Supplemental habitat and range information for Federally-listed (**F**) and State-listed (**S**) threatened (T) , endangered (E), and special concern (S) animal species utilizing wetland habitats to forage, rest, or breed. Habitat symbols* and range symbols** are given at the end of the table.

Species	F	S	Forage/Rest	Breed	Range
Alligator mississippiensis (American alligator)	T	S	MF, SM, SP, FW	FW	LP to LS
Caretta caretta caretta (loggerhead sea turtle)	T	T	—	BB	UM to DT
Chelonia mydas mydas (green sea turtle)	E	E	—	BB	UM to DT
Crocodylus acutus (American crocodile)	E	E	MF, SM, SP, BB, DT	BB, DT, MF, SM	KL
Diadophis punctatus acricus (Big Pine Key ringneck snake)	—	T	SL, HH, FW, DT	FW, HH, SL	NN to BT
Drymarchon corais couperi (Eastern indigo snake)	T	T	All habitats	SL, HH, BB, HB	KL to US
Eretmochelys imbricata imbricata (hawksbill sea turtle)	E	E	—	BB	UM to DT

Kinosternon bauri bauri (Key mud turtle)	—	E	SL, HH, HB, FW, DT	SL, HH, FW	LP to KW
Storeria dekayi victa (Florida brown snake)	—	T	SL, FW, HH	SL, FW, HH	NN to LS
Thamnophis sauritus sackeni (Florida ribbon snake)	—	T	SL, HH,SMH HB, FW	FW, HH, SL	NN to LS
Charadrius alexandrinus tenuirostris (southeastern snowy plover)	—	T	BB, SP	—	All Keys
Charadrius melodus (piping plover)	T	T	BB, SP	—	All Keys
Columba leucocephala (white-crowned pigeon)	—	T	SL, HH, MF, HB	MF	All Keys, FB
Falco peregrinus tundrius (peregrine falcon)	T	E	All habitats	—	All Keys
Falco sparverius paulus (Southeastern American kestrel)	—	T	All habitats	—	All Keys
Haliaeetus leucocephalus (bald eagle)	T	T	All habitats	MF, FW, SL	LP to KW, FB
Mycteria americana (wood stork)	E	E	MF, SM, SP, MSM, SML	—	KL, FB
Sterna antillarum (least tern)	—	T	BB, DT, OW	DT	All Keys
Sterna dougallii (roseate tern)	—	T	BB, DT, OW	BB, DT	All Keys
Vermivora bachmanii (Bachman's warbler)	E	E	HH, HB, BB, MF, SM, BSM, MSM, FW	—	All Keys
Odocoileus virginianus clavium (Key deer)	E	E	All habitats	HH, SL, BB	LP to LS
Oryzomys argentatus (silver rice rat)	E	E	MF, SM, MSM, SML, BSM, FW	MSM, HB, SM SML, FW	LP to SB
Sylvilagus palustris hefneri (Lower Keys marsh rabbit)	E	E	SMH, FW, BB, HB, BSM	SMH	BP to BC

*Key to habitat symbols

BB = beach berm
BSM = buttonwood salt marsh
DT = disturbed habitat
FW = freshwater marsh/pond
HB = high buttonwood
HH = tropical hardwood hammock
MF = mangrove forest
MSM = scrub mangrove marsh
OW = open water
SL = slash pinelands
SM = scrub mangrove
SMH = open salt marsh - high
SML = open salt marsh - low
SP = salt pond

**Key to range location symbols

BC = Boca Chica
BT = Big Torch Key
DT = Dry Tortugas
FB = Florida Bay islands
KL = Key Largo
KW = Key West
LP = Little Pine Key
LS = Lower Sugarloaf Key
NN = No Name Key
SB = Saddlebunch Keys
UM = Upper Matecumbe Key
US = Upper Sugarloaf Key

- listing of these species on both Federal and State levels indicates a special need to focus on their recovery,
- the breeding habitats of these five species are critical to their survival and recovery,
- the two mammal species and the crocodile are restricted to very specific parts of the Keys, and,
- the two mammal species currently continue to decline and all species have been shown to be intolerant of any further loss or significant disturbance of their breeding habitat.

Documentation supporting the crucial role that certain intact wetlands play in the breeding success of these animals can be found in Moler, 1992 (reptiles), USFWS, 1983 (crocodile), USFWS 1993 (marsh rabbit), Humphrey, 1992 (rice rat and marsh rabbit), and Rogers et al., 1996 (bald eagle). In summary, Keys wetland habitats that are crucial to the breeding success of Federally protected animal species are by definition highly functional and thus were red-flagged.

Native Fresh/Oligohaline (F/O)
Native or naturalized wetlands on marl or caprock substrates that exhibit surface water salinities of 5 ppt or less at any given time of the year, but not necessarily year-round; and wetlands that are vegetated with freshwater species such as sawgrass (*Cladium jamaicense*), cattails (*Typha* spp.), and/or spikerush (*Eleocharis* spp.). Succession to these wetlands can occur in ponded areas in the vacant interior of developed keys, where native salt marsh may have once existed. For example, marl is deposited by blue-green algae living in second-growth spikerush marshes. In contrast, dredge and fill canal lots are not naturalized.

Method: Freshwater wetlands were easily identifiable by the field team using vegetation, salinity (measured with a refractometer), or mapped information.

Rationale: There are roughly 1,000 acres of freshwater habitat remaining in the Keys (see discussion above under "Wetland Losses to Development"). Almost all of it is in the Lower Keys. A quick review of Table 5 shows at least eight listed animal species that require freshwater wetland habitat. Virtually all other wildlife, including the thousands of neo-tropical migrant birds that stop along the Keys each spring and fall, also depend on the availability of fresh water. The evolution of local endemic forms of herpetofauna is a direct result of living in a Keys landscape that includes persistent, dependable sources of fresh water (Jackson, 1989). This resource translates into an extremely high return in terms of habitat value for plants and animals for the relatively small acreage of remaining wetlands. This value was recognized in 1986 by Monroe County when they began to prohibit development in freshwater wetlands. Regardless of the condition of the wetland, the presence of seasonal or persistent fresh water is of such high functional value that all of these wetlands were red-flagged.

Below Seasonal High Water and Not Permanently Impacted (SHW)
"Seasonal High Water (SHW)" is defined as the landward edge of the supratidal ecotone, i.e., that zone influenced by surface tides. It can be determined by direct observation, or by identifying the vegetative indicators of the supratidal and nontidal habitats given in the list of

cover types (Figure 22). Seasonal water connection may be surface or, particularly through the Key Largo limestone of the Upper Keys, subterranean. Therefore, it is possible to identify a supratidal wetland landward of a nontidal habitat. Wrack lines produced by equinoctial tides and seasonal wind effects may also be used to locate seasonal high water.

"Permanently Impacted" is defined as topographically altered such that succession to the original wetland community is not likely. The original hydrologic input to the wetland is absent. Impacted areas typically are covered with silty or gravelly fill, are above daily tides, and lack evidence (near-surface saturated soil) of subterranean tidal influence. An area may have locally or temporarily disturbed soil or vegetation resulting from vehicular use, trash dumping, mosquito ditching, mowing, cutting, etc., without being permanently impacted.

Method: Wetlands below the seasonal high water line were identified in the jurisdictional mapping portion of the ADID. Wetland cover classes on the FMRI maps that were assumed to be below seasonal high water included all mangrove forests, scrub mangroves, salt marshes, and salt ponds, as well as buttonwood wetlands that are adjacent to mangroves, salt marshes or salt ponds. These cover classes allowed the team to use the FMRI maps as a surrogate for the jurisdictional maps. The FMRI maps were corrected where deviations appeared from the seasonal high waterline on the jurisdictional maps, and where a boundary between AAs crossed a cover class polygon. The polygons were then re-digitized where necessary and used to demarcate this red flag category.

Rationale: Wetlands that are regularly flooded, whether daily or seasonally, are of relatively high importance in carrying out the major functions assessed in KEYWEP. These wetlands maintain the Florida Keys ecosystem continuum by providing direct connection of emergent and submergent habitats. They are the first to receive the impact of tidal storm water and they are the final recipient of rainwater runoff before it enters nearshore waters. Regular flooding of these wetlands also provides expanded habitat with greater stability for plants and animals. All of these wetlands are currently off-limits to development at the local level. Due to their well documented and widely recognized functionality and their integral role in maintenance of a larger tropical ecosystem, they were red-flagged.

Green Flag Wetlands

Hydrologically Disconnected and Wetland Vegetation Precluded

Wetlands that were above the SHW line or that were below the SHW line but "permanently impacted" did not qualify for red-flagging unless they fell under one of the other three red flag categories. These non - red-flag wetlands were further evaluated based on their hydrology and vegetation and placed into one of two groups: (1) green flag wetlands, or (2) wetlands which were run through the model. These groups are explained further below. The field sheet for green flags is shown in Figure 24.

Non - red-flag wetlands that (1) are hydrologically disconnected from the inflow of water, and in which (2) wetland vegetation is precluded are green flag wetlands. These two concepts are defined before proceeding to an explanation of the rationale behind green flag wetlands.

"Hydrologically Disconnected" means that the wetland is hydrologically altered such that persistence of the original wetland community is not likely. Alteration can be the result of

diking by roads or spoil banks, drainage by mosquito ditches, or filling that changes the hydroperiod or frequency of tidal inundation. Hydroperiod refers to frequency, duration and depth of inundation in freshwater wetlands and supratidal brackish waters. Disconnection is demonstrably obvious in filled waterfront lots, where the frequency has decreased from that of average tidal cycles to that of major storm events in some cases. Effect of sea level rise is excluded from this definition.

"Wetland Vegetation Precluded" means that the wetland is not providing evident support for rooted macrophytes or algal mats, as indicated by consensual field evaluation or interpretation of aerial photography by the functional assessment team. While native hydrophytes may be present, if the AA is already dominated by invasive exotics (though they are listed nationally as hydrophytes) it may be presumed that eventually native wetland vegetation will be essentially precluded.

Method: Green flag wetlands generally had to be identified or confirmed in the field, rather than relying strictly on remote assessments. The team had to judge in the field both the preclusion of wetland vegetation and the normalcy of the circumstances at each site. As will be seen in the KEYWEP results, very few green flags were identified over the course of the project.

Rationale: Again, the primary purpose of flagging wetlands was to avoid the expenditure of significant resources on the assessment of wetlands with obvious exceptionally high or low value. Green flag wetlands were judged to exhibit little, if any, discernable ability to perform the functions modelled in KEYWEP. Most of those functions are severely diminished by permanent alteration of hydrology and vegetation.

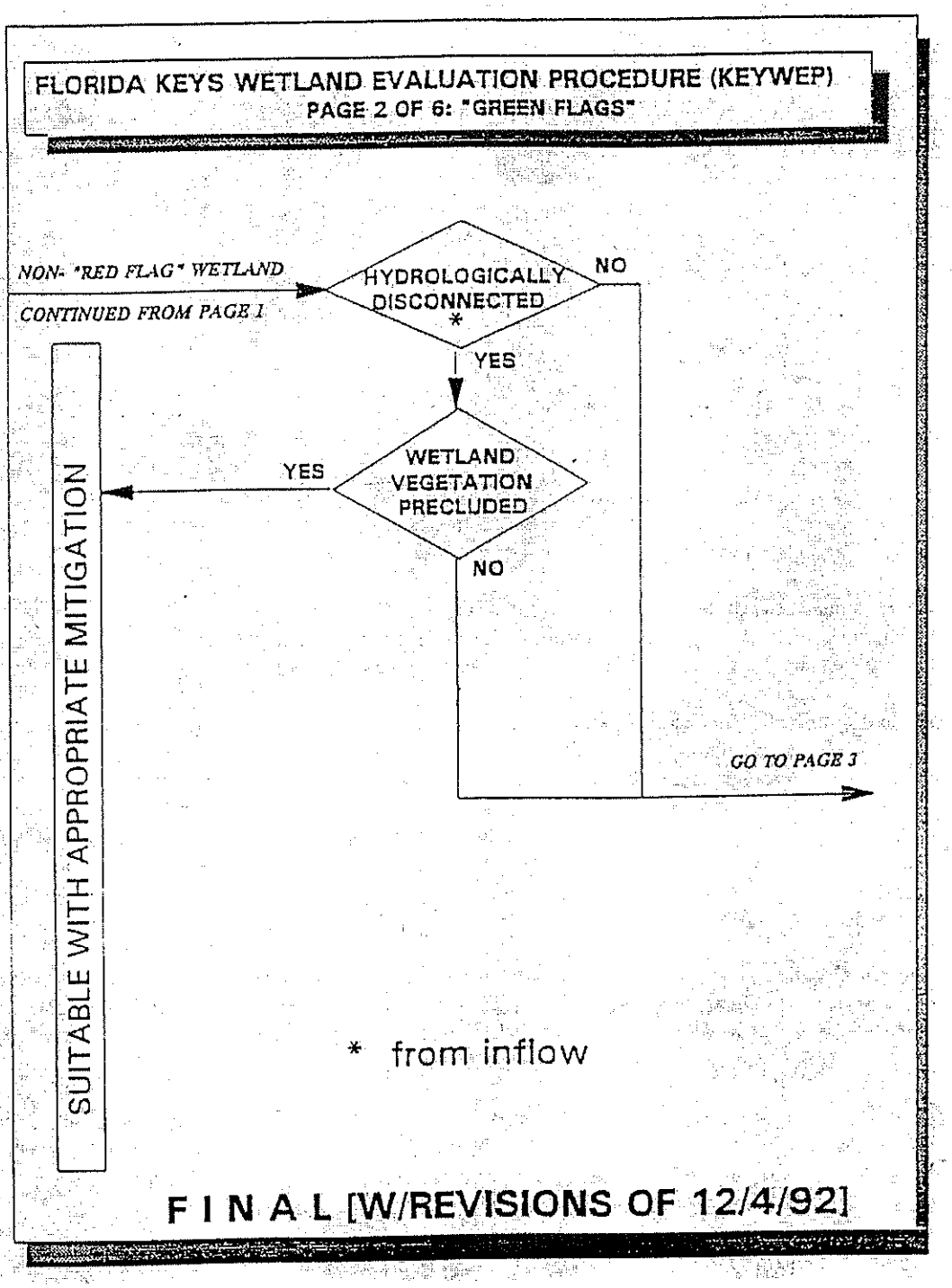


Figure 24. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Green Flags" field assessment sheet.

Assessment areas that could not be flagged were run through the KEYWEP model to determine the level of each wetland function. The definition, methodology and rationale for each function are as follows.

Water Quality Functions

Water Quality was the first of the three major functional categories evaluated in KEYWEP (see Table 4). The highest possible total score for water quality functions was 2.0 (Figure 25). Water quality functions in the Keys are of direct importance mainly to nearshore waters. The small land mass and random pattern of drainage on Keys islands diminishes their normal watershed functions. There is essentially no watershed in the normal sense of the word. This fact plus rapid drainage through porous substrate limits water handling functions in the Keys and therefore justifies a lower weighting for them in KEYWEP relative to other functions. This weighting by no means diminishes their historical and current value in performing water quality functions. Wetlands that filter runoff en route to receiving water bodies (which are often a very short distance away) provide clean water to estuarine areas and also greatly reduce direct sediment loading from rain events. The latter benefit is immediately obvious to the casual observer of a developed residential canal after a heavy rain shower, when limerock sediments enter the water directly and create a chalky plume (Figure 26).

Nutrient and Contaminant Retention

This function is the ability of the substrate to recycle or sequester potential pollutants by geochemical molecular processes (e.g., cation exchange) and soil bacterial metabolism. It is scaled by a variable that corresponds to composition of the substrate as follows: High = peat or marl; Interim = crushed limerock or exposed Key Largo limestone; Minimal = exposed Miami oolite.

Method: The team determined the predominant substrate type in the AA as one of the above-listed categories and scored the variable accordingly. For remote assessments the field team visited representative samples by wetland class and location until they were confident of the predominant substrate in each one.

Rationale: The binding of certain nutrients, especially phosphates, by calcareous substrates has been documented by Lapointe et al. (1990) and others (Seibold and Berger, 1982; Brady, 1990). Lapointe and his co-workers in fact found elevated nitrogen to phosphorus ratios as distance increased from the on-site sewage disposal facilities being studied. Their results indicated that phosphorous "is removed, though not completely, by movement through

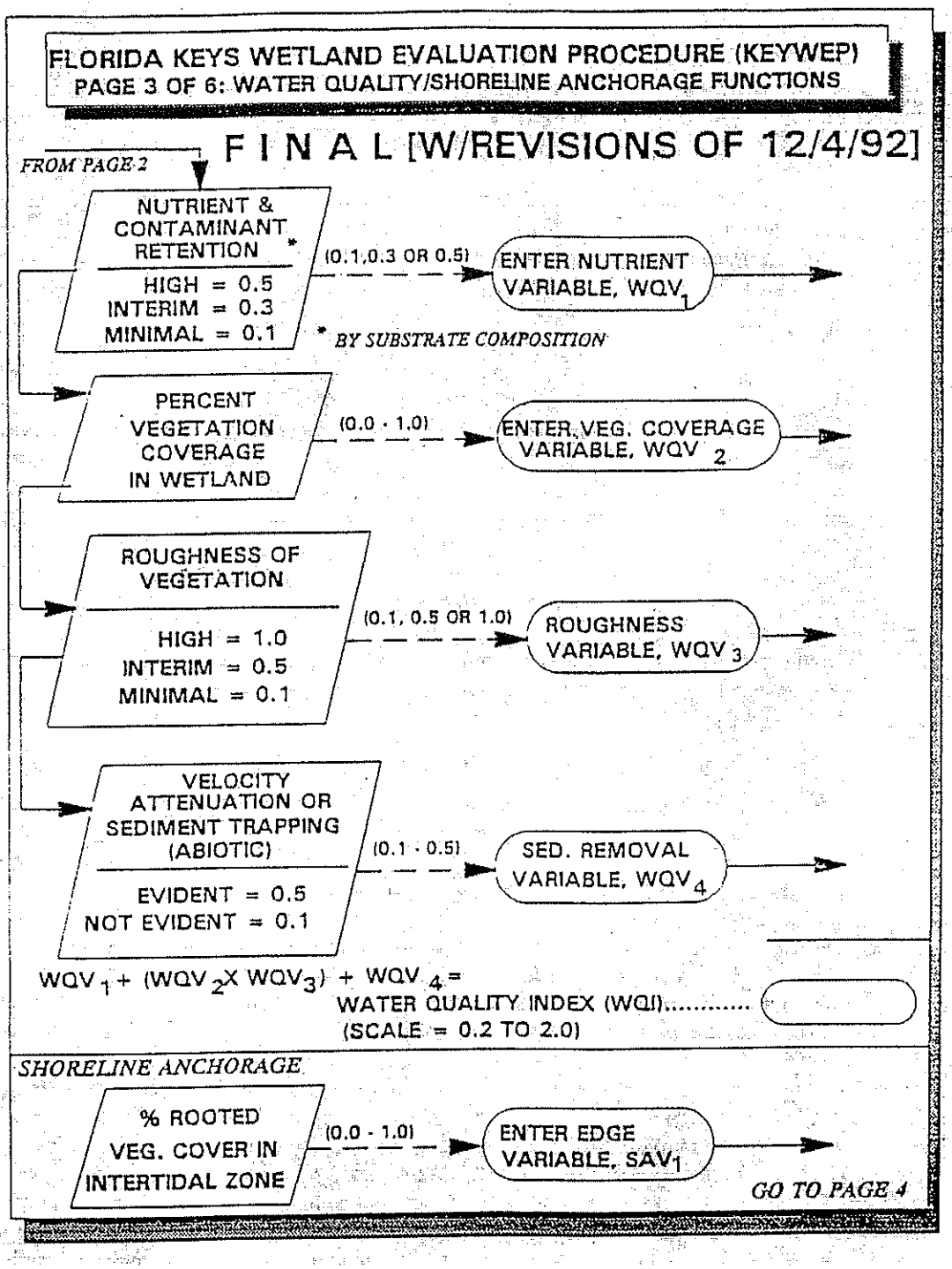


Figure 25. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Water Quality/Shoreline Anchorage Functions" field assessment sheet.

subsurface carbonate substrata of the Keys" (Lapointe et al., 1990). This phenomenon was observed at a reduced rate in saline Key Largo limestone groundwater, perhaps due to competition between effluent and seawater for phosphate sorption sites, "a phenomenon also observed in Bermuda's groundwaters" (Lapointe et al., 1990).

Wetlands with deposits of marl or peat, and even limerock fill which has been worked by regular flooding to produce loosely aggregated fine particles, have greatly increased surface area for adsorption of contaminants including metals, nutrients, and hydrocarbons (Tisdale et al., 1985). Anearobic marls and peats can also effect denitrification (Gordon et al., 1986). Removal of excess nutrients and associated pollutants is a highly rated function due to problems associated with excess nutrient loading of nearshore waters (Lapointe et al., 1990; Paul et al., 1995a; Paul et al., 1995b). It is especially beneficial in the nutrient-poor subtropical environment of the Florida Keys, where excess nutrients can severely impair the ecological balance of nearshore communities adapted to low nutrient availability. Rapid turnover of biomass, high biodiversity and clear water are characteristic of the tropics given the low availability of free nutrients (in detritus, sediments, dissolved in water, etc.). Nutrients are cycled quickly and tied up in living biomass, making for intense competition. The introduction of chronic loads of excess nutrients from anthropogenic sources may cause imbalances in the ecosystem by allowing a competitive advantage for algae growth (Lapointe, 1989), followed by a subsequent lowering of diversity and ecosystem stability. Wetlands can play a large part in absorbing excess nutrients, and in fact have recently been built or allocated specifically for that function (Bastian and Benforado, 1988).

Percent Vegetation Coverage in Wetland

Percent vegetation coverage is scaled as follows:

0% = 0	20 - 39% = 0.3	60 - 79% = 0.7	100% = 1.0
1 - 19% = 0.1	40 - 59% = 0.5	80 - 99% = 0.9	

This same scale is used for both "wetland" (areal estimate) and "intertidal zone" (between mean water marks) in the Shoreline Anchorage box (linear estimate).

Method: The team visually estimated the percent cover of wetland vegetation on the AA and then classified it according to the scale above. This value is used as a multiplier with the "roughness" variable (see below) to generate a total amount of roughness function for the wetland. Estimates of percent cover for remote assessments were performed using aerial photography.

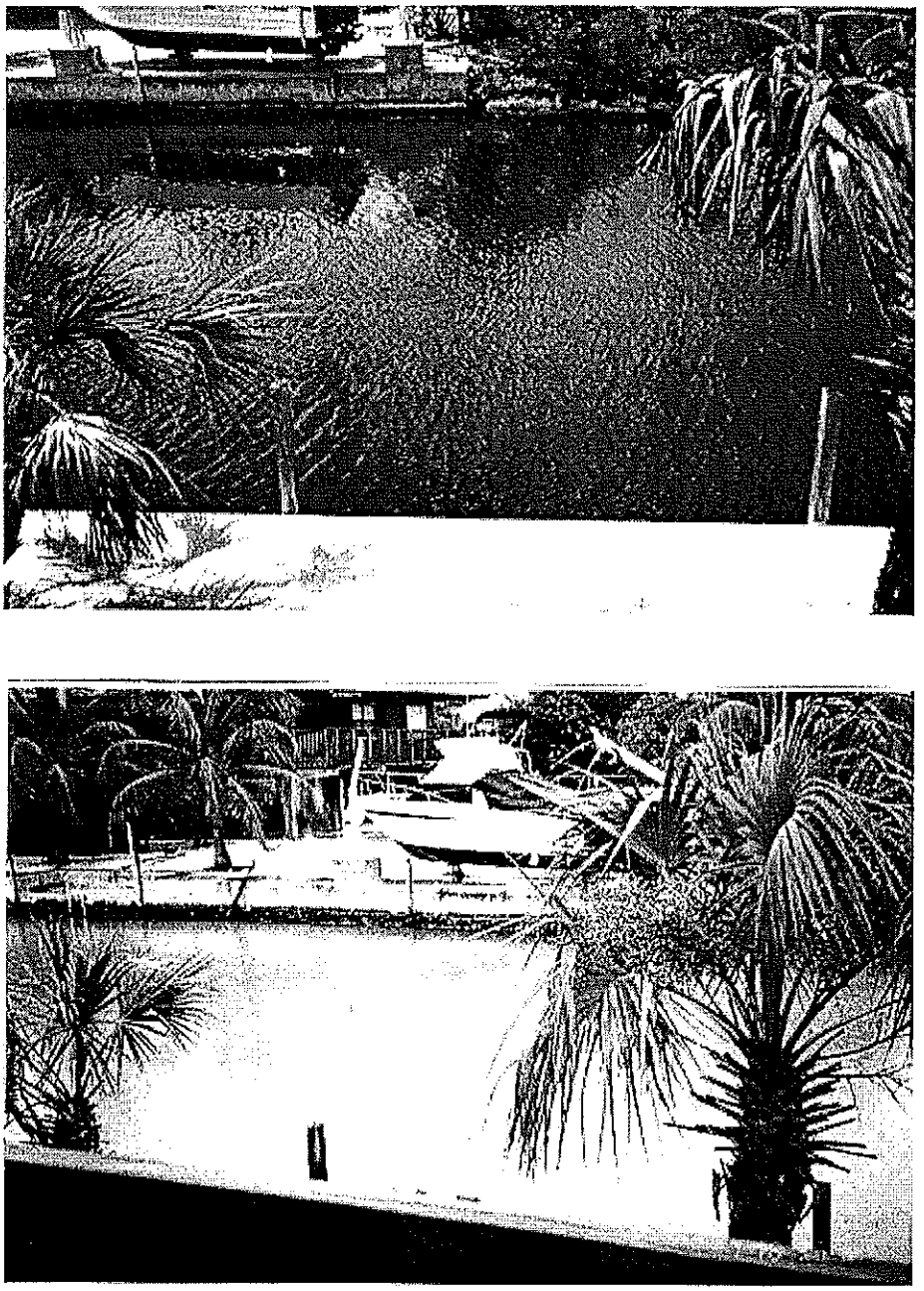


Figure 26. Photograph of residential canal on Summerland Key before (above, by Jeanette Hobbs) and after (below, by Pat McNeese) a rain shower showing change to chalky color after acute loading of limerock fill sediments from adjacent lots.

Roughness of Vegetation

"Roughness" attempts to qualify the ability of vegetation to slow the flow of surface water or trap and hold sediment. It is scaled by a variation on Manning's Coefficient. See discussion below for derivation and examples.

Derivation - The top line in the progression shown below is an approximate scale for Manning's n, a coefficient of roughness used in hydrology (Gore, 1996). The middle line represents the positions of published values for various surfaces and types of vegetation. Florida Keys equivalents of these types were assigned appropriate positions on the scale and grouped on the bottom line into three categories of roughness: minimal (M), intermediate (I), and high (H).

.01	.05	.10	.20	.30	.40	.50	.60	.70	.80
a	b	c	d		e				f
		M		I			H		

Definitions - M = non-succulent herbs, or sparse grasses, e.g., *Sporobolus* and *Paspalum*.
I = tuft-forming grasses, e.g., *Spartina*, *Fimbristylis*, *Juncus*, etc., or erect woody vegetation except as in H below.
H = succulent herbs or turf-forming grasses (e.g., *Sesuvium*, *Monanthochloe*, *Distichlis*), dense black mangrove pneumatophores or red mangrove prop roots, or dense ground-branching shrubs.

Because obstruction of sheet flow is the phenomenon of interest for this variable, vegetative cover includes stems, prostrate leaves, and aerial roots, and is considered to a height of only 1 inch.

Method: The field team determined and characterized the predominant vegetation type in the AA according to the definitions provided by Manning's coefficient. The corresponding value was then multiplied by the percent cover value to produce a vegetative functional variable (See Figure 25). Where vegetation of high and minimal roughness were codominant the interim roughness value was used. For remote assessments, representative samples along with interpretation of vegetative cover types from aerial photographs were used.

Rationale: The ability to slow the movement of surface water before its release into nearshore water bodies allows two things to occur: deposition of sediments and uptake of nutrients by plants. Adamus and Stockwell (1983) noted that "most vegetated wetlands are excellent sediment traps, at least in the short term, and ample literature suggests that many wetlands accrete sediment for long periods." Retention of up to 94% of incoming sediment has been reported for palustrine emergent wetlands for example (Adamus and Stockwell, 1983). The plants remove nutrients, especially nitrogen and phosphorus, and store them in above or below-ground parts (Tiner, 1998). One Philadelphia study showed a 50 to 70 percent reduction in the nitrate and phosphate levels of sewage effluent several hours after the waters passed over a 500 acre tidal marsh (Grant and Patrick, 1970). A review of 11 wetland systems in the Southeast in which annual mass nutrient balance studies were performed concluded: "All of the studies showed that the wetlands acted as sinks for total nitrogen and phosphorus" (Nixon and Lee, 1986). Three studies done for heavy metals "...showed the systems to behave as sinks for all of the metals examined..." (Nixon and Lee, 1986). For mangrove swamps evidence shows "...nutrients are removed and oxygen consumed by a combination of periphyton on mangrove prop roots, mud, organic detritus on the sediment surface, the fine root system of the mangroves, small invertebrates, benthic and epiphytic algae and bacteria and fungi on all these surfaces" (Odum, et al., 1982). The percent cover factor helps to indicate the degree to which this function is performed in a given

wetland. Again, nutrient and sediment removal and control are especially important in the subtropics where excess availability can lead to imbalance of the nearshore submerged ecosystem. The greater the ability to slow the movement of surface water as it passes through the wetland, the greater the opportunity for the wetland to perform this function.

Velocity Attenuation or Sediment Trapping
This function is evaluated by a variable that reflects the decrease in velocity of runoff or quantity of sediment suspended in that runoff. These decreases are caused by any natural or manmade feature of the substrate that slows erosive forces or increases the rate of sedimentation. Indicators include formation of detrital lines and deposition of sediment in solution holes and microtopographic depressions.

Method: The field team determined the predominant presence of indicators of sediment trapping in the AA. For remote assessments the team used representative samples by wetland type and location.

Rationale: Where wetlands provide depressions and holding areas, water-borne sediments drop out of suspension, lowering turbidity and reducing siltation of nearshore waters (Tiner, 1998). These features therefore expand the ability of the wetland to perform the important sediment and contaminant removal functions described above.

Shoreline Anchorage Function

Shoreline anchorage is an important wetland function that provides water quality and habitat benefits. It is generally not applicable to closed water bodies (those without surface connection to open waters at mean low water). However, it was used in the ADID on shorelines of interior waters that have a significant fetch, such as Lake Edna on Grassy Key or the Key West Salt Ponds. Shoreline anchorage can be considered primarily a water quality function providing erosion and sedimentation control for nearshore waters. Its use on inland waters was based on the best professional judgement of the field team as to whether that function was being performed at a specific site.

Method: The percent rooted vegetation cover in the intertidal zone was estimated for wetlands bordering shorelines. The field team classified the shoreline in one of the percent cover groupings under the "Percent Vegetation Coverage in Wetland" variable (see field sheet in Figure 25), based on a visual estimate of the percent cover of rooted vegetation in the intertidal zone of the assessment area.

Rationale: buffering of uplands from water-generated erosion, increased durability of soil through binding with roots, stabilization of banks, dampening of wave energy through friction, and reduction of current velocity and the erosive potential of floodwaters (Tiner, 1998). Knutson (1988) states, "There is ample laboratory and field evidence to allow us to conclude that:

- coastal marshes dissipate energy associated with waves, currents, and storm surges,
- the energy dissipation accomplished by marshes provides increased opportunities for sediment deposition and decreased potential for erosion,

- the roots and rhizomes present in marsh sediments measurably increase sediment shear strength, reducing marsh erodibility,
- energy dissipation and root reinforcement in marshes produce measurable reductions in shore erosion and preclude coastal erosion."

Sediment stabilization is extremely important for the Florida Keys ecosystem. Chronic loading of sediments (Figure 26) leads to disruption of the ecosystem via two immediate routes: loading of excess nutrients bound to sediments and disruption of filter feeders (mainly corals and other Anthozoans). Shoreline stabilization by vegetation provides a quality habitat for all growth stages of marine life by providing a shaded, buffered area protected from the extremes of both uplands (runoff and erosion) and nearshore waters (waves and currents).

Stormwater Functions

Stormwater storage functions are the second major group evaluated. Due to the high porosity of keys substrates and the small land masses of the islands, these function rated lower in importance than the others, with a total possible high score of 1.0. The Keys on the whole do not store large quantities of rainwater or tidal water for any significant length of time. In fact, storage is most notably observed during exceptionally high tide and storm events, when the ground is saturated by the extremely high water table. Stormwater problems in the Keys are largely exacerbated by widespread, concentrated development of impervious surfaces. Figure 27 depicts the stormwater field sheet.

Rate of Infiltration

Infiltration is the downward movement of surface water past the soil surface. It is scaled by permeability of the substrate as follows: High = exposed Key Largo limestone or weathered Miami oolite (oolite heavily fractured and containing numerous solution holes); Intermediate = peat or marl; Minimal = intact oolite or compacted crushed limerock.

Method: The field team determined and classified the predominant substrate type in the AA as one of the above-listed categories and scored the variable accordingly. For remote assessment, representative samples by wetland type and location were used to characterize substrate type.

Rationale: In areas of rapid infiltration, there is a greater chance that surface water runoff will be captured and drained through the wetland than in areas of less permeable substrate. This function is important for protection against damaging flood levels (both in human and wildlife terms) especially during seasonal heavy rain or storm events. Greater flood storage (or handling) potential can generally be attributed to more permeable, less saturated substrate (Adamus and Stockwell, 1983) such as Key Largo limestone. Infiltration in combination with surface storage area (see below) expands a wetland's stormwater storage capability.

Surface Water Expansion

This function is the ability of a wetland to hold water on site. Surface water expansion is an indication of the water storage capacity of the assessment wetland. There may be evidence that water stands on the AA following storm events, though it does not have permanent

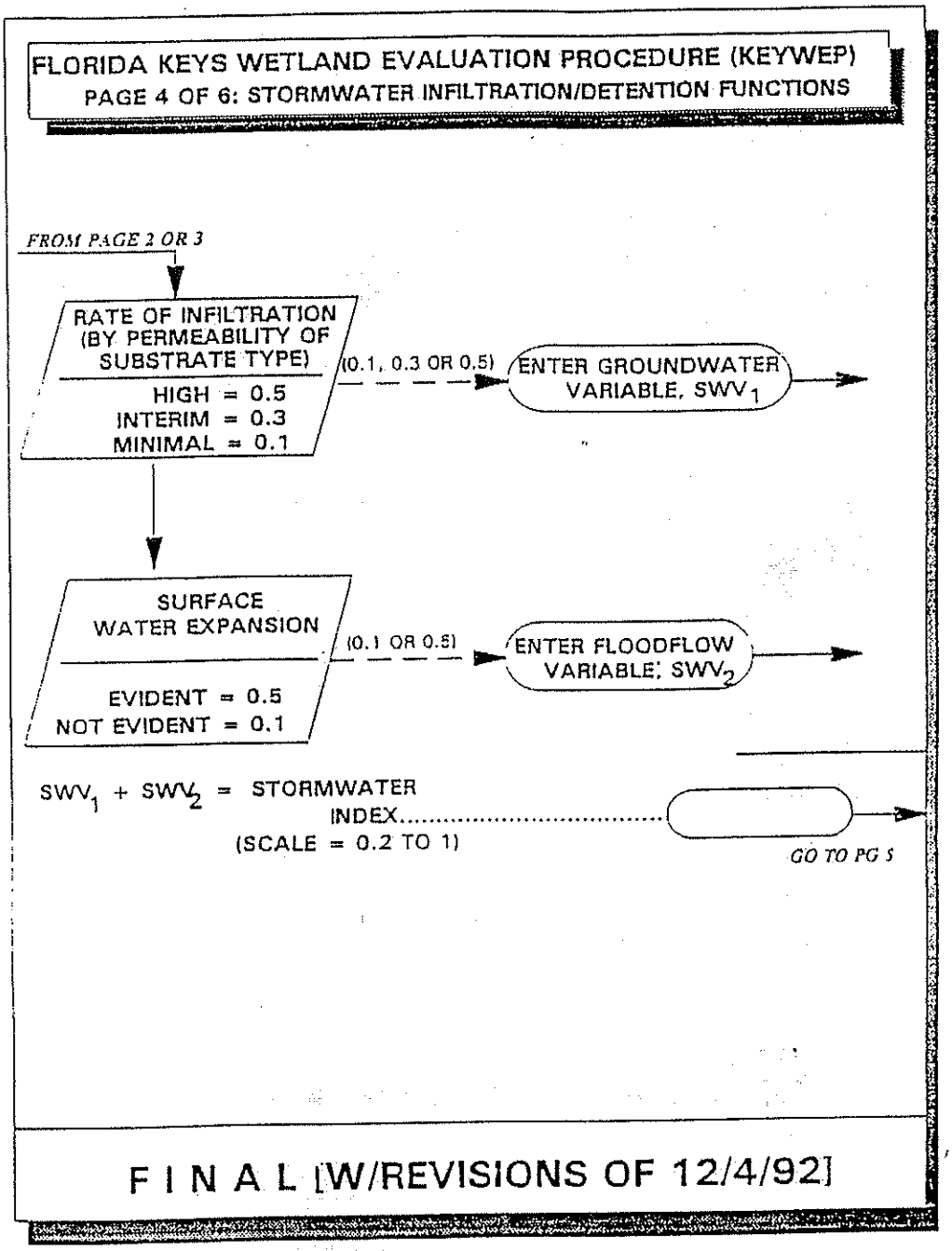


Figure 27. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Stormwater Infiltration/Detention Functions" field assessment sheet.

surface water. Indicators of surface water expansion include soil saturation, accumulation of silt on vertical surfaces, and presence of microtopographic depressions.

Method: The field team determined the prevalence of indicators of surface water expansion and scored the AA accordingly. Representative samples for the water holding capacity of various wetland types were used for remote assessment.

Rationale: Surface water expansion is an important function of seasonally flooded wetlands in that they act as expanded flood water storage areas during major storm events in the Keys. Also, the more water a wetland can hold, the more capacity it has to allow siltation and nutrient uptake before the water is released. Saturation of the interstitial spaces between sediment grains is an important factor in maintaining wetland activity throughout the the long Keys dry season (acting as a side benefit to stormwater storage).

Habitat Functions

The KEYWEP habitat functions sheet is displayed in Figure 28. As shown at the bottom of that sheet, habitat variables add up to the largest possible score of any of the functions (total of 4.0). As mentioned previously, the geology, geography and size of Keys wetlands limit their benefits for both stormwater and water quality functions. The Florida Keys is a premier wildlife habitat and wetlands are a major part of that ecosystem which supports a striking diversity of plants and animals. Therefore, the most important and most heavily weighted function of KEYWEP is habitat quality.

Evidence of Adequate Surface Water

"Adequate surface water" is demonstrated by standing water that persists long enough to be colonized by aquatic organisms. The potential for fish and aquatic macroinvertebrates to colonize a temporary wetland is partly a function of the duration of surface water inundation. The primary field indicator of "adequacy" is the presence of fish. Other indicators are the presence of macroinvertebrates requiring constantly wet conditions, such as marsh clams, ladder horn snails, and coffee bean snails; active or aestivating aquatic stages of aquatic insects; or relatively extensive and well developed algal mats. Consensual professional judgement of the field team is required for interpretation of algal mats. Mats resume growth following dormancy after approximately 30 days of continuous inundation (USEPA, 1994).

Method: The team evaluated this variable using the field indicators listed above. At least one reliable indicator must have been observed on the AA. For remote assessments, representative samples were used for various wetland types especially with respect to wetland hydrology.

Rationale: Adequate surface water must be present to allow colonization by species that serve as food for wildlife. Many of the organisms that serve as food items for higher animals depend on the marsh themselves as a food source. The mummichog *(Fundulus heteroclitus)* for example has been shown to exhibit significantly higher growth rates when exploiting the salt marsh surface during times of flooding: "Although food was available in the subtidal portion of the habitat, it was of insufficient quantity for fish at natural density to grow at a normal rate, and mummichogs must utilize the marsh surface for at least a portion of their energy intake" (Weisberg and Lotrich, 1982). Therefore, adequate surface water ranges from that amount that allows a temporary (but regular) availability of a food source (i.e., fish, tadpoles, *Ruppia*, etc.) or a continuous availability (i.e., permanent wetland inhabitants).

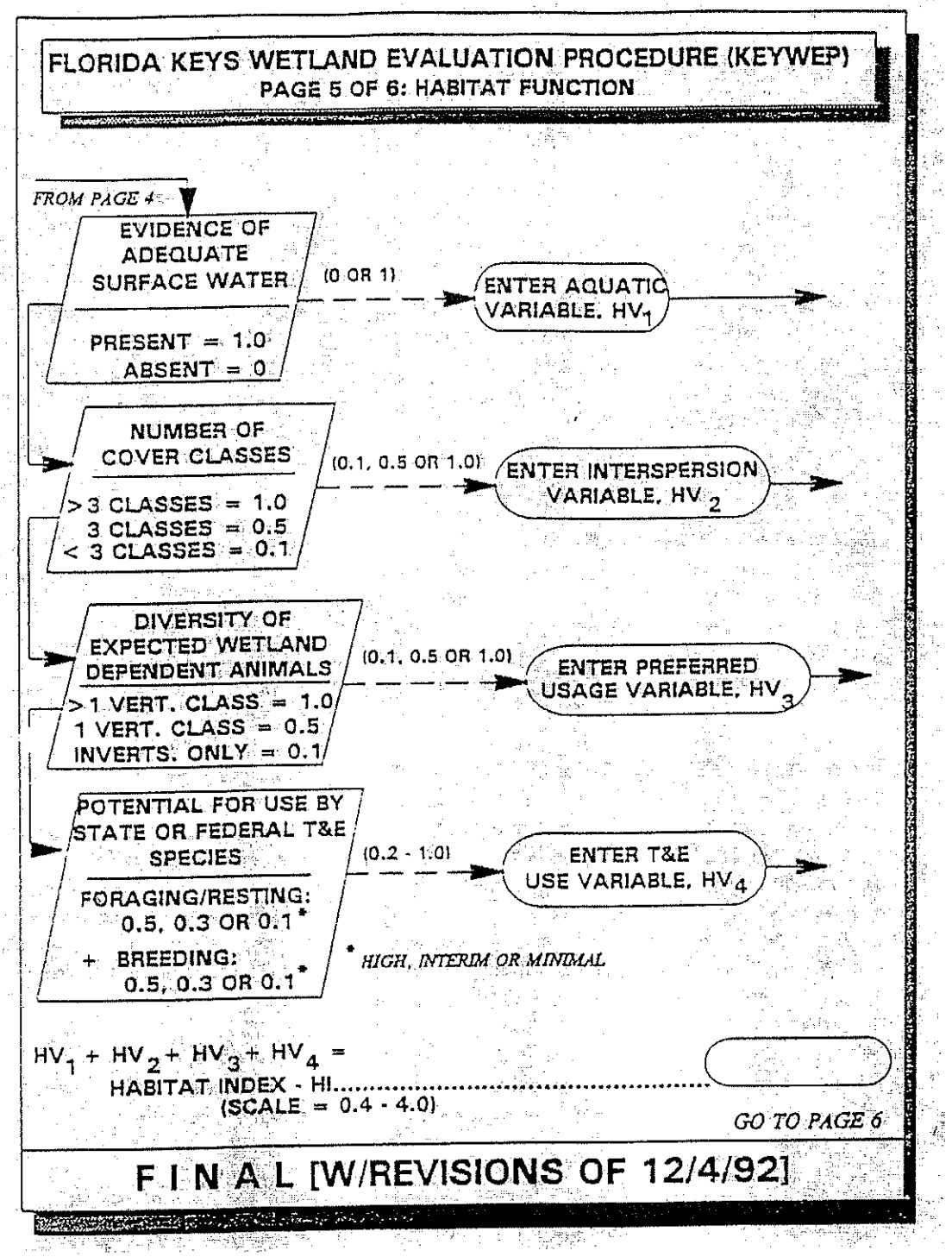


Figure 28. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Habitat Functions" field assessment sheet.

Number of Cover Classes

This variable is defined by the number of habitat types (e.g. wetland cover classes listed above) in the AA, or immediately adjoining it so as to include native upland types. This contiguity is in contrast to mere proximity of habitats as viewed at the landscape scale (see below), where intervening disturbances such as roads and canals may not constitute a barrier

to movement of the selected animals across the landscape. Adjacent habitats must actually touch the AA to be included for purposes of evaluating the number of cover classes. For remote assessments, habitats were classified from remotely sensed data, by photo-interpretation, or through other consensual judgements of the field team. Upland habitats classified as
"exotics-dominated" or "disturbed" were not counted.

Method: The team used field observations, mapped habitats, and/or aerial photographs to classify and enumerate the number of cover classes on or next to the AA according to the above guidelines.

Rationale: An increased number of cover classes will increase the diversity and usefulness of the wetland for animal species (especially birds) by providing both insular and edge habitats (Adamus and Stockwell, 1983, Folk, et al., 1991). This diversity is especially important too for the mass movement and dispersion of wildlife during the rainy season. Alternating open and densely shaded cover classes facilitate the movement of wildlife over large areas during this time.

Diversity of Expected Wetland Dependent Animals
"Expected" means that it is reasonably probable (in the consensual judgement of the field team) that a given taxon is using the AA for breeding, feeding/watering, resting, or dispersing, given knowledge of the range, distribution, vagility, and habitat requirements of the local terrestrial fauna. This same knowledge is used to evaluate the potential for use by listed species (see variable below and red flag category above). In practice, "1 Vert[ebrate]. Class" (Figure 28) typically equates to birds being the only expected class, due to the vagility of shore and wading birds and waterfowl and their ability to exploit waters of varying salinity.

Method: This variable is based on observations at the AA and best professional judgement of the field team. For remote assessments, representative samples by wetland type were used to characterize expectation of wetland dependent animals.

Rationale: This variable follows up on the "adequate surface water" variable to evaluate wetland use by higher trophic levels. A wetland's ability to assimilate and cycle energy is most evident to the field observer in the wetland's use by multiple trophic levels and guilds. This makes for a greater complexity in the food web, an increase in niche availability and a general increase in system stability (Odum, 1975). Use may be quite temporary but seasonally necessary, as with the blue-winged teal which exploits salt ponds during early winter when *Ruppia* is plentiful. In fact, Bellrose and Trudeau (1988) cite the "...differential use of wetlands [by birds] as a key to survival."

Potential for Use by State or Federally Listed Animals
This variable is evaluated for listed animal species using the same criteria given above for all wetland dependent animals. A threatened or endangered species is any animal designated as threatened or endangered according to the most recent listing of the U.S. Fish and Wildlife Service or the Florida Game and Fresh Water Fish Commission.

"Potential for use" (Figure 28) is equated to presence of required habitat that is sufficiently undisturbed and of adequate size and proximity to a known population, based on range

information on file in the Keys Field Office of the Florida Game and Fresh Water Fish Commission or the Monroe County Environmental Resources Department, the local scientific literature, and best professional judgement of the ADID field team. Lists of species and the habitats they use accompany KEYWEP (Table 5). The values in Figure 28 of 0.5, 0.3, and 0.1 correspond to findings of probable, possible, and negligible use by listed species, respectively. In contrast, the red flag for use by listed species is restricted to known breeding areas.

Method: The State and Federal threatened and endangered animal species listed at the time the ADID project was conducted are shown in Table 5. The field team combined known ranges, sitings, and breeding information for these animals with their known habitat requirements in the Keys to draw conclusions about the AA. The presence of State and Federal wildlife biologists on the field team greatly enhanced the efficiency and reliability of this and other habitat variables evaluated.

Rationale: The rationale behind evaluating AAs for their potential as foraging, resting, and breeding habitat for threatened and endangered species is based on several factors:

- listing of these species on both Federal and State levels indicates a special need for focus on their recovery and success,
- breeding, foraging and resting habitats are critical to the survival and recovery of these species,
- many of these species are restricted to very specific locations in the Keys, and,
- many of these species continue to decline and all have been shown to be intolerant of any further loss or significant disturbance of habitat.

Documentation supporting the crucial role that wetlands play in the breeding success of these animals can be found in Moler (1992), Humphrey (1992), and Rogers (1996). In summary, wetland habitats that are crucial to the recovery and success of protected animal species are of high functional value, due to their ability to support specialized, sensitive, and/or formerly widespread local species. The presence of threatened and endangered wildlife indicates a high level of ecological stability and biodiversity.

Landscape Effects on Habitat

An important feature of a wetland's habitat quality is its landscape position, especially in the context of habitat fragmentation and development in the Keys. As previously stated, all wetlands are presumed to have the opportunity to perform water handling functions, but not all can serve as beneficial habitat where behavioral, physical or ecological barriers to wildlife use exist. Figure 29 shows the landscape effects sheet for KEYWEP. The two variables are explained below. They must be evaluated independently of each other. As with the rest of KEYWEP, it is contemplated that persons applying the model in the future will follow the methods established for the ADID .

Community Connectivity

Community connectivity is the extent to which the AA is an accessible part of the native ecosystem. It is scaled by the proportion of a target group of species for which the AA and its accessible surroundings provide all critical life history requirements. For KEYWEP, requirements consist of cover classes and minimum area or typical home range size. Habitat on the AA need not be high quality; it need only match the surrounding cover class. Surroundings are accessible if there are no intervening physical or behavioral barriers to animal movement. On the accompanying lists (Tables 6 and 7) a group of target species is given for each of the three broadly defined (by plant species composition and physiognomy) wetland categories in the Keys, followed by the habitat requirements of those species. These particular animals were selected because they preferentially inhabit intact native landscapes, their requirements for space vary over a broad range, and their life history requirements are sufficiently well known. The target species are:

American crocodile	*Crocodylus acutus*
Eastern indigo snake	*Drymarchon corais couperi*
mangrove cuckoo	*Coccyzus minor*
prairie warbler	*Dendroica discolor*
Key deer	*Odocoileus virganianus clavium*
marsh rabbit	*Sylvilagus palustris hefneri*
silver rice rat	*Oryzomus argentatus*

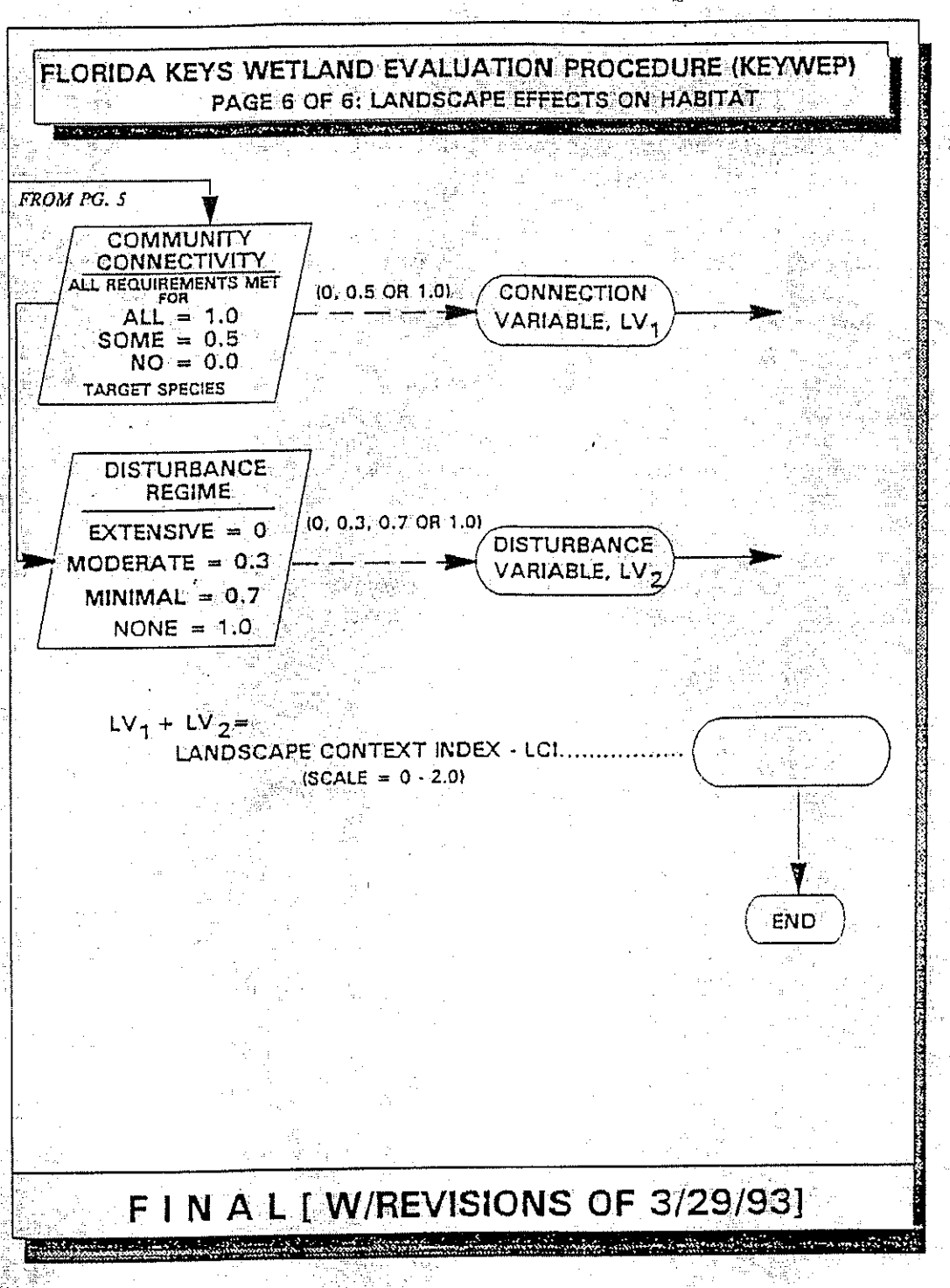


Figure 29. Florida Keys Wetland Evaluation Procedure (KEYWEP) "Landscape Effects on Habitat" field assessment sheet.

Table 6. Target species for "Community Connectivity" variable of the Florida Keys Wetland Evaluation Procedure (KEYWEP).

(Use all habitats that apply.)

Mangroves[1]

Lower Keys	Middle/Upper Keys
mangrove cuckoo[2]	mangrove cuckoo[2]
prairie warbler[3]	prairie warbler[4]
Key deer[5]	American crocodile[6]

Low Open Salt Marsh/Buttonwood Salt Marsh

Lower Keys	Middle/Upper Keys
silver rice rat[7]	prairie warbler
Key deer	Eastern indigo snake[7]

High Open Salt Marsh/Freshwater Marsh

Lower Keys	Middle/Upper Keys
marsh rabbit[8]	marsh rabbit[8]
Key deer	Eastern indigo snake

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[1]Not applicable to strips along edges of canals and borrow pits.

[2]Forest (per cover class list) + hardwood hammock (closed canopy).

[3]Scrub class + forest class + undisturbed buttonwood salt marsh.

[4]As in footnote 3 above but do not use on North Key Largo.

[5]Scrub; use habitat supplement (Table 5).

[6]Scrub + forest. Use only on North Key Largo.

[7]Use habitat supplement (Table 5).

[8]High open salt marsh + freshwater marsh + buttonwood salt marsh.

Table 7. Estimates of minimum area or home range for target species used in the "Community Connectivity" variable of the Florida Keys Wetland Evaluation Procedure (KEYWEP).

Species	Range (acres)	Description/Notes
mangrove cuckoo	30	forest cover class* + (closed canopy) hammock
prairie warbler	3	tall, dense scrub
	5	scrub class + forest class + buttonwood salt marsh (undisturbed)
Key deer	100	all habitats listed in supplement (Table 5)
American crocodile	100	includes salt ponds
silver rice rat	50	includes mangroves and low hammock
Eastern indigo snake	100	total wetlands and uplands
marsh rabbit	3	core habitat of open grasses
	10	total habitats listed in supplement (Table 5)

*mangrove forest, freshwater hardwoods or high buttonwood.

Method: The field team used best professional judgement to characterize habitat accessibility (while ignoring habitat quality) for each target species applicable to the vegetative communities being assessed. Presence of the actual species in or near the AA was not required. The team determined whether or not the AA was an accessible piece of a sufficiently large patch of listed habitats. Access corridors, if required for connectivity, must have been comprised of listed habitats as well, and must have been wide enough to provide sufficient cover for routine travel. For remote assessments, aerial photographs were used to judge accessibility.

Rationale: The previous habitat variables assessed the usefulness of a wetland as wildlife habitat based on non-spatial characteristics, such as duration of flooding, vegetative cover diversity, presence of food sources, etc. Community connectivity evaluates the opportunity for wildlife use by characterizing the spatial adequacy and accessibility of a wetland to Keys animals. It uses the home ranges and behavioral habits of "indicator species" as representatives of the local fauna by which to judge Keys wetlands. The resource needs and barriers to accessibility for each target species are documented in life histories and recovery plans or are based on local expert knowledge [Folk et al.,1990 (Key deer); Forys, 1993 (marsh rabbit); Hoffman, pers. comm. (prairie warbler); Jacobson, 1983 (crocodile); Moler, unpub. (indigo snake); Spitzer, 1983 (rice rat); Strong and Bancroft, 1994 (cuckoo)].

Disturbance Regime

Disturbance regime is the degree to which natality and mortality of the target species are (or would be, if they utilized the AA) adversely affected by current domestic, recreational, commercial, or industrial activity. These effects on essential wildlife activities are caused by

behavioral changes due to competitive displacement by humans, or to predation or resource competition by human commensals. Such impacts stand in contrast to direct, physical habitat destruction or degradation by development. Due to their geography, the bridged Keys have a certain background level of disturbance even in remote areas. This level is designated as "none" for KEYWEP purposes. Many unbridged Keys are also subjected to disturbance.

Method: Consensual judgement of the field team was used to characterize the amount and type of development surrounding the AA. For example, heavy residential development in an improved subdivision was considered an "extensive" disturbance regime, while one or two residences or a small office building on an acreage tract were considered a "minimal" disturbance regime. Spatially, the scale in Figure 29 is exemplified as follows: Surrounded by development = 0; adjacent to development = 0.3; close to development but buffered from it = 0.7; and no nearby development = 1. This scale was in turn adjusted for the typical home range sizes of the species in question, where a small spatial disturbance has a greater impact on an animal with a small range. However, in addition to density of development, the activities (secondary impacts) normally associated with given developments were considered. Note that these activities often extend far beyond the limits of actual disturbance by humans, e.g. in the case of predation by unrestrained dogs and cats.

Rationale: Similar to the community connectivity variable, the disturbance regime variable adds another "dimension" to assessment of the habitat quality of a wetland, that is, the opportunity to carry out life history processes in a natural setting without interference. Sources of interference are those that alter the natural behavioral or developmental processes of the target species. Most of these sources come from the secondary impacts of human development including displacement, movement barriers, predation and competition (Folk et al., 1990; Folk et al., 1991).

APPENDIX II: EPA-COE MFR ON WETLAND JURISDICTION

MEMORANDUM FOR RECORD

CLEAN WATER ACT SECTION 404 JURISDICTION OVER FILLED LOTS IN CANAL SUBDIVISIONS OF THE FLORIDA KEYS

INTRODUCTION

An Advanced Identification (ADID) (40 CFR 230.80) of wetland areas in Monroe County is being prepared. This ADID will depict the location of natural wetlands and filled areas which are wetlands throughout Monroe County. Many areas of the Keys which were filled to create residential lots adjacent to marginal channels or tidal canals are wetlands because of their elevation. The purpose of this memorandum is to provide a scientifically defensible and standardized methodology to be used during the ADID process to determine the jurisdictional status of filled subdivision lots in the Florida Keys. This memorandum also serves as applicable guidance for regulatory delineations, subject to amendment as discussed on page 8.

The ADID is being prepared for planning purposes. Because of the size of the mapping units and the geographic scope of the ADID, there may be upland inclusions in areas mapped as wetlands, particularly on filled lots. Thus, jurisdictional determinations for permit requests in natural wetlands and filled lots may require additional field work to ascertain the exact jurisdictional status of the entire site.

The criteria for delineating federal wetlands are described in the Corps of Engineers Wetlands Delineation Manual (1987 Manual). This discussion of the application of the 1987 Manual to filled residential lots in Monroe County is based upon Dr. Peter Kalla's Draft Issue Paper (February 11, 1994) and arose from interagency field work and discussions held on March 4, 1992, September 20, 1993, and April 22, 1994. The methodology is intended only for filled subdivision lots in the Florida Keys. Application of the methodology to other geographic areas may not be appropriate.

Canal subdivisions were created in the Florida Keys through placement of dredged material in waters and/or wetlands to raise the elevation of the filled area. Most filled subdivisions were created in the 1950's and 1970's and are "finger-fill" canal systems. The existing, filled condition of areas which were previously waters and/or wetlands represents the "normal circumstance" for these areas. Thus, jurisdictional evaluations must be performed on the conditions as they exist today and not on their pre-disturbed condition.

Filled subdivision lots in the Florida Keys represent a unique set of conditions which make the determination of their jurisdictional status very challenging. The nature of the fill material used to create the lots and its position in relation to

surface or ground water results in the slow development (geologic time) of normal hydric soil indicators. Determination of the hydroperiod of these sites is difficult because of the marked seasonality and wide fluctuations of rain and tide events and the porosity and permeability of filled soils in the Keys. Thus, filled subdivision lots are an example of a Problem Area as described in Section G of the 1987 Manual. Problem Areas are wetland types in which wetland indicators of one or more parameters may be periodically lacking due to normal seasonal or annual variations in environmental conditions that result from causes other than human activities or catastrophic natural events. In Problem Areas the application of indicators of one or more parameters is difficult, at least at certain times of the year.

Filled subdivision lots show a broad range of vegetative cover and many are unvegetated or partially vegetated. If disturbance by man can be ruled out, the existing vegetational status must be considered the normal circumstance. Lack of vegetation over all or part of a lot may be due to a variety of factors including soil compaction upon deposition, vehicular and/or foot traffic, or other unknown factors. Unauthorized alteration or removal of vegetation is a condition described in Atypical Situations (Section F) of the 1987 Manual. Methods described in Section F should be used only when positive indicators of vegetation, soils, and/or hydrology are not found due to effects of recent human activities or natural events. However, the presence of hydrophytic plants may not be conclusive because hydrophytic species may survive on filled areas in tropical climates in response to moist soils and humid air and not in response to inundation and/or saturation to the surface.

SOILS

Filled subdivision lots are disturbed sites where marine sediments have been deposited on the pre-existing surface to provide land for residential development. Two basic kinds of material were used to create filled lots. Offshore marl was hydraulically dredged and crushed rock fill was excavated by dragline. The marl and crushed rock fill are marine deposits which now provide the medium for growth of emergent plants on the filled lots. Because of the characteristics of "marly" soils in tropical regions and the marked seasonality of wet and dry periods, and because the soil has been recently deposited, few filled sites demonstrate hydric soil indicators. Because canal-front residential lots were created from fill material, the soil characteristics of these seasonally wet areas should be ignored for the purposes of making a wetland determination (1987 Manual Section G).

It could be argued that since marine deposits were formed under water, the spoil that was used to create the residential lots must be a hydric soil. While this conclusion may be logical,

placement of a marine deposit in a dry area may result in the development of an upland community on former marine deposits. Similarly, it could be argued that the Soil Conservation Service in Florida lists all marl soils as hydric. However, marl soils can be placed in uplands and act as upland soils. For these reasons, it is best to use hydrological and plant indicators for making wetland determinations on these disturbed sites.

The soils of the filled lots are a major controlling influence on hydrology. Crushed rock fill material appears to be very hard and is difficult to sample with a screw auger. However, this medium is quite porous as evidenced by its drainage on Big Pine Key after a hard rain event on April 23, 1994. After that rain event, the entire profile of the crushed rock fill was moist, indicating that water readily percolates through that medium at that site. More detailed studies are required to determine the speed and extent of drainage of crushed rock soils in the Florida Keys. Marl fill has the capacity to hold more water than crushed rock and has a higher degree of capillarity. Thus, given the same position in the landscape, a marl lot would be expected to be wetter than a crushed rock lot.

Ponding of surface water is an indication of a confining layer (aquatard) within the soil resulting in a lack or very slow movement of surface water vertically through the soil. Ponding of surface water can occur on subdivision lots of either medium if soil pores become clogged and an aquatard is formed. Ponded areas can occur on low portions of lots where fine sediments accumulate. Ponded areas are characterized by a heavy growth of algae on the soil surface (commonly called "periphyton") if the hydroperiod is of a sufficient duration (usually 30 days).

VEGETATION

A prevalence ($\geq$50%) of hydrophytes among the dominant emergent plants is required to successfully meet the hydrophytic vegetation parameter. Ponded areas with a vegetative cover of only periphyton (blue-green and other algae) are not wetlands since emergent hydrophytes (vascular plants) are absent.

The 1987 manual does not establish a threshold of plant cover; it requires a determination of dominance of the existing plants. The vegetative parameter is met when greater than 50% of the dominant plants have a vegetative indicator status of FAC, FACW, or OBL. Determination of dominance in vegetated subdivision lots may require quantitative sampling.

Some filled lots are unvegetated or sparsely vegetated. Reasons for this condition can only be determined through detailed studies. However, some general principles can be established. If a lot is very sparsely vegetated and only marginally meets the

hydrology criterion, it can be assumed that conditions are not conducive to growth of hydrophytes. However, if a lot which clearly meets the hydrology criterion is sparsely vegetated, reasons for the lack of vegetation must be ascertained. If the existing soil conditions permanently and unalterably preclude the growth of emergent plants (e.g. very compacted soils) the area cannot be a wetland. If the soils are not markedly compacted, the reasons for sparse vegetative cover may be more difficult to determine. Factors to consider include soil hypersalinity, pedestrian traffic, vehicular traffic, shading, mowing, and herbicides. If the influence of man has temporarily resulted in lack of vegetation or in sparse vegetation, Section F of the 1987 Manual should be used to delineate the area as if the influence were removed. Adjacent vegetated sites or the remnant vegetation of the disturbed site may be used to determine plant dominance.

HYDROLOGY

The method described herein for use in determining the jurisdictional status of filled canal lots in Monroe County is a combination of Sections F and G of the 1987 Manual. Because of potentially altered plant communities and lack of development of hydric soil indicators, the method relies heavily on a determination of hydroperiod. A minimum hydroperiod of 5% of the growing season is required for a wetland determination. Since the growing season in the Florida Keys is year-round, a minimum hydroperiod of 18 consecutive days is required. The minimum hydroperiod is usually used in circumstances where the other parameters clearly allow a wetland determination (positive plant and soil indicators). It is used herein because of the manipulation of the other parameters and the highly seasonal nature of the Keys' hydrologic regime. A higher threshold for positive indication of hydrology (12% of the growing season) may be justified depending on site specific conditions.

Specific hydrologic regimes can arise from a combination of tidal over-washing, an accumulation of rain water and runoff, and tidal saturation through porous soils. Water must remain at the surface (i.e. root zone, usually within 12 inches of the surface) of the soil for 18 consecutive days to satisfy the hydrologic threshold for a wetland determination. If the surface of a filled lot is at an elevation which allows regular and periodic over-wash of tidal water during the period of seasonally high tides (September-October), the portion of the lot which is tidal during that period meets the hydrological criterion. Regular and periodic tidal flooding "includes high spring tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm" (33 CFR 328.3 (d)). The remainder of the lot may or

may not meet the hydrological criterion depending upon the length of time of any surface ponding and/or soil saturation from rain and movement of tidal water in soils.

Ponding of rain water and runoff may occur on all or part of a lot in areas where soil pores are clogged with fine sediment or the sediment is compacted (thus acting as an aquatard). Ponding generally occurs in low places on such lots. Mats of periphytonous algae are formed during conditions of prolonged ponding of surface water and are an indication of approximately 30 days of inundation. If ponding is of a sufficient duration to result in periphyton growth, wetland hydrology has been met.

The 1987 Manual lists "visual observation of soil saturation" as a positive field indicator for wetland hydrology. If the depth to the water table is within 12 inches of the surface, it is normally concluded that capillary action will result in saturation within the root zone (surface). The height of the capillary fringe varies with soil texture.

The height of the water table in filled canal lots is a function of rainfall, tidal height, soil porosity, and elevation. Unless there is some reason to suspect otherwise (ponded areas), canal lots filled with crushed rock or marl fill are quite porous. Rain water which percolates through the soil seeps into the adjacent canal when the height of water in the canal does not prevent it. During extended periods of high tides, which coincides with periods of heavy rains, a freshwater lens may accumulate within the soil on top of the tidal water. Because of the complexity of tidal patterns in the Keys and the lack of closely spaced tidal reference stations, an exact determination of height of the freshwater lens and underlying tidal waters within canal lot soils is difficult to accurately determine. Therefore, for the present time, hydrological determinations for such lots must be based on an estimate of the elevation of water in the soil below the surface of the lot.

For lots with no aquatard, a positive hydrological determination will be based on the elevation of the filled area. The maximum lot elevation that allows for continuous soil saturation in the root zone is between the mean fall high tide level and mean sea level, with additional water elevation provided by hydraulic friction (which retards tidal ebbing in canal backwaters), thickness of the freshwater lens, and capillarity of the soil. An estimated sum of these parameters for the middle and lower Keys is 3 feet NGVD. Thus, for the purposes of the ADID, on filled canal-front lots with no aquatard, an elevation of 3 feet NGVD or less will be considered to be a positive indicator of wetland hydrology in the middle and lower keys. Persons conducting ADID advisory delineations on such lots in the upper Keys will use

all locally available information and their best professional judgement to determine an appropriate elevation for that area.

Site specific jurisdictional determinations for permit applications will rely on more detailed field work as necessary. Supplemental guidance on the depth to saturation in fill material during the wet season will be made available after completion of additional field work on the groundwater hydrology of fill soils in the Florida Keys, as well as further research on the tidal dynamics of the Keys.

METHOD TO DETERMINE CLEAN WATER ACT SECTION 404 JURISDICTIONAL STATUS OF FILLED LOTS ADJACENT TO ARTIFICIAL CANALS AND CHANNELS IN THE FLORIDA KEYS, MONROE COUNTY, FLORIDA

1. Waterward of the seasonal high water line.....waters of the U.S.
   Landward of the seasonal high water line.....2

2. Water ponded on soil surface or evidence of ponding on surface (aquatard present).....3
   Water not ponded and no evidence of ponding on surface....7

3. Evidence of long-term ponding, such as development of periphytonous algal mats on soil surface.....4
   No evidence of long-term ponding. May exhibit evidence of short-term ponding such as fine sediment deposits in microtopographic depressions, sediment lines, or animal tracks.....not a wetland

4. Emergent plants present.....5
   Emergent plants absent.....6

5. > 50% of dominant plants are FAC, FACW, or OBL.....wetland
   ≤ 50% of dominant plants are FAC, FACW, or OBL.....not a wetland

6. Vegetation manipulated by man (e.g. mowed).....wetland (Atypical)
   Vegetation not manipulated by man.....not a wetland

7. Average grade is at or below the elevation (NGVD) that allows for seasonal soil saturation in the root zone for a minimum of 18 consecutive days, due to high tidal groundwater and other hydrologic factors.....8
   Average grade is above that elevation.....not a wetland

8. Emergent plants present.....9
   Emergent plants absent.....10

9. > 50% of the dominant plants are FAC, FACW, or OBL..wetland
   ≤ 50% of the dominant plants are FAC, FACW, or OBL.....not a wetland

10. Soils permanently altered, not capable of supporting emergent hydrophytes.....not a wetland
    Soil alteration not permanent; soil capable of supporting emergent hydrophytes if alteration is removed.....wetland (Atypical)