

Direct Impacts of Personal Watercraft (PWC) on Submerged Aquatic Vegetation (SAV) in Maryland's Tidal waters

Final Report December 2002



**Prepared by Tidewater Ecosystem Assessment Division of
the Maryland Department of Natural Resources for Maryland
General Assembly (COMAR 4-213.1)**



Maryland Department of Natural Resources
Tidewater Ecosystem Assessment
580 Taylor Avenue, D-2
Annapolis, Maryland 21401
www.dnr.state.md.us

Contact Dr. David Goshorn for more information:

Toll free in Maryland: 1-877-620-8DNR ext. 8630

Out of State call: 410-260-8633

TTY via Maryland Relay: 711 (within Maryland)

800-735-2258 (out of state)

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Summary

Submerged aquatic vegetation (SAV) beds are among the most ecologically important habitats in Maryland's estuaries and are essential for healthy fish and shellfish populations. The restoration and protection of SAV beds is a primary goal in the restoration of Maryland's tidal waters.

Recent concerns of impacts to SAV from personal watercraft (PWC) have been voiced to Maryland Legislators. In response to these concerns of potential direct impacts to SAV beds by PWC use and the limited existing evidence on direct PWC impacts to SAV, the 2000 Maryland General Assembly passed § 4-213.1 calling for the Department of Natural Resources to conduct a study, make recommendations and report to the Governor and General Assembly by January 1, 2003.

Based on low level aerial photography and field experimentation, SAV does not appear to be substantially directly impacted by PWC's except under the following conditions:

- SAV leaves are clipped by the PWC jet pump intake when they lay near or directly on the waters surface.
- Long term PWC related activity (high speed acceleration and/or trampling of SAV by PWC operators in a confined area).

Damage to SAV from indirect PWC effects (turbidity, toxicity, etc) was not addressed in this study, and would require a much more exhaustive effort to adequately evaluate.

Other impacts to SAV beds were clearly visible from aerial photographs, presumably from hydraulic clam dredging and other boating-related activities.

In order to minimize the impacts of PWC's on SAV beds, we recommend the following: PWC operator education, channel marking in high-use areas to minimize area of direct impacts, and the establishment of regulations which allow Natural Resource Police officers to issue warnings and/or citations when PWC operators ignore channel marking buoys in high use areas.

Direct Impacts of Personal Watercraft (PWC) on Submerged Aquatic Vegetation (SAV) in Maryland's Tidal waters

Introduction

Despite their fairly recent introduction to the boating scene, personal watercraft (PWC) or Jet Ski®, Waverunner®, Sea Doo®, etc. have quickly become an issue of controversy. A PWC is a boat less than 16 feet in length that uses an internal combustion motor powering a water jet pump as its primary source of propulsion. It is operated by a person sitting, standing, or kneeling as opposed to the conventional manner of boat operation.

Inexpensive and easy to trailer, PWC's are able to move quickly at nearly any water depth. In addition, PWC's frequently operate in very shallow waters that are extremely important habitat areas. Maryland has invested large sums of money to improve water



Fig 1 - PWC and recreational boat activity south of the Rt. 90 bridge in Ocean City, Maryland.

quality in these very areas with hopes of restoring the resident submerged aquatic vegetation (SAV) beds that are vital to our tidal ecosystem. While a study performed in the Florida Keys indicated that the operation of PWC in depths of water greater than two feet did not detrimentally affect local SAV (Continental Shelf associates, Inc, 1997), very little information has been available on the impacts of PWC's on SAV species common to Maryland.

Currently in Maryland, there are no specific regulations addressing PWC activity in SAV beds. However, regulations have been recently adopted (08.18.02.05.p, in response to HB 73) requiring PWC users operating in 18 inches of water or less not to exceed idle speed under normal conditions (Appendix 1). This regulation may afford some protection to SAV growing in 18 inches or less of water. Other regulations may also protect SAV when PWC's are banned in areas which are also inhabited by SAV (Assateague Island National Seashore). In addition, the Department of Natural Resources may also adopt regulations limiting the use of PWC's in any area of water with a depth less than 40 inches (one meter).

In response to concerns of potential direct impacts to SAV beds by PWC use, the 2000 Maryland General Assembly passed § 4-213.1 calling for the Department of Natural Resources to conduct a study and report to the Governor and General Assembly by January 1, 2003.

Objectives

Investigate the direct impacts of PWC on SAV in Maryland's tidal waters through assessment of low level aerial photography, groundtruthing and field experimentation. If results show that PWC's directly impact SAV, make recommendations to address these impacts.

Methods

Assessment of low-level aerial photography

Low-level aerial photographs (scale: 1"=170') were taken on seven occasions from October 1998 through July 2000 in Isle of Wight Bay, Worcester County, Maryland (Fig. 2) of near shore habitat to characterize SAV scarring. This area was chosen because of the large SAV beds in close proximity to varying degrees of boating/PWC activity. The 9"x9" photographs were digitally scanned at 200 pixels per inch (ppi) and geo-referenced to ortho-photo quarter-quadrangle maps. The outlines of SAV beds were traced directly upon the scanned images as a vector layer, with the original photographs used to help clarify information in complex areas. Near-shore scars in several areas were delineated on-screen to determine if scars were expanding, receding, or remaining unchanged. Field verification of scarring was performed after each set of scars were photographed. *Note: Currently, Virginia Institute of Marine Science (VIMS) photographs SAV beds for the annual SAV survey from 12,000' and digitizes images from the 1"=24,000' scale images.*

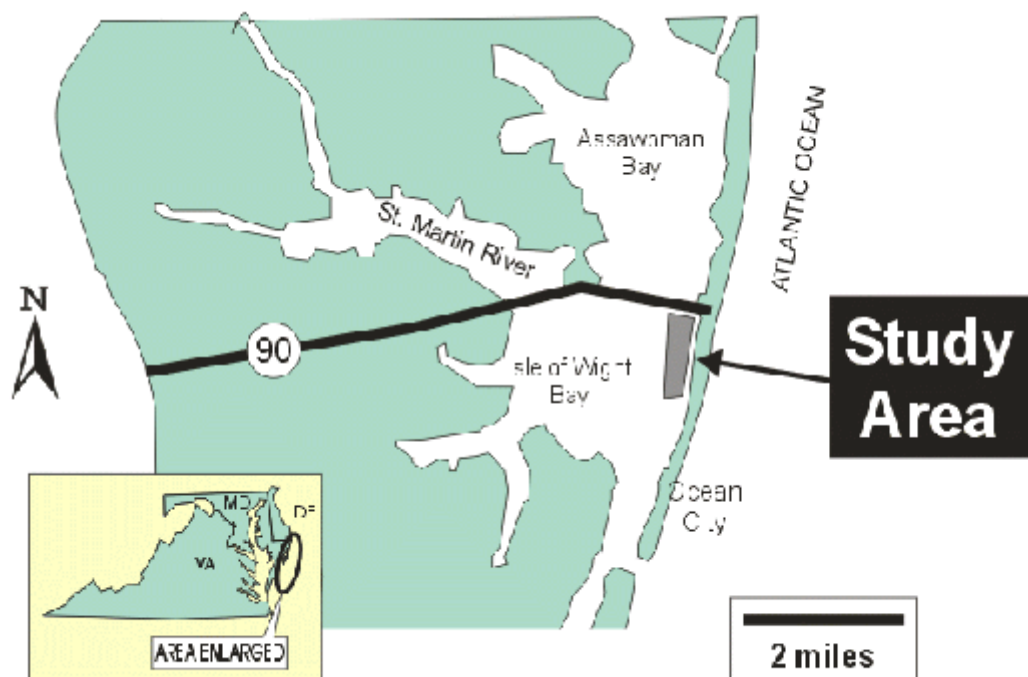
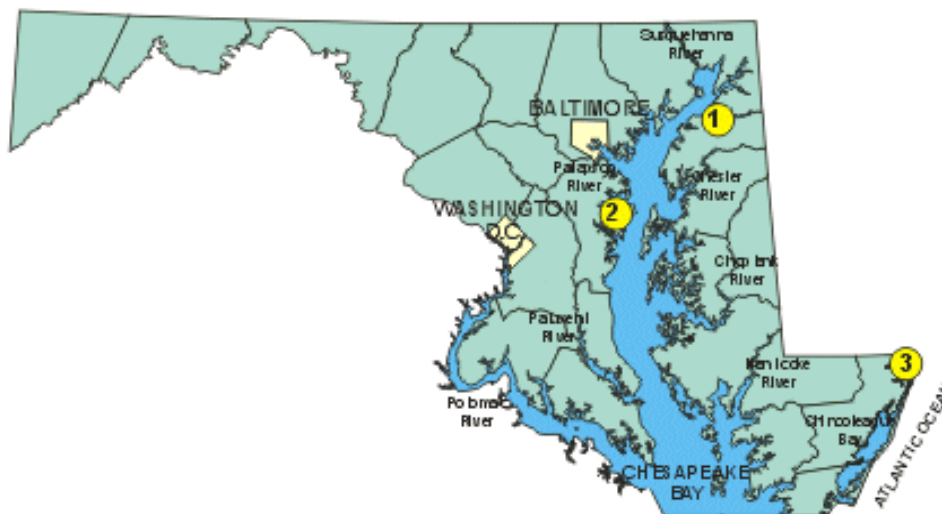


Fig 2 - Low-level aerial photography study area (October 1998 through July 2000)

PWC Field Experimentation

Field experiments were conducted in three Maryland tidal areas: Sassafras River/Lloyd's Creek (Kent County), Severn River (Anne Arundel County), and Isle of Wight Bay (Worcester County)(Fig. 3). The locations were chosen to represent common SAV populations present in Maryland waters at low (0-6 parts per thousand (ppt)), middle (5-14 ppt) and high salinities (15-35 ppt), respectively. At each location, multiple variable speed passes with Bombardier Sea-Doo GTX 2 and 4 stroke PWC's were performed in dense SAV beds in depths of water approximately 40" deep to measure direct PWC impacts on shallow water SAV beds. One square yard quadrats were examined before and after being exposed to 20 to 60 PWC passes at idle speed (<5mph), 20 to 60 passes at full speed (approximately 30 mph) and 20 to 60 standing starts. Impacts were assessed using underwater video and by measuring plant density and height before and after the multiple PWC passes.

PWC Study Areas & Local SAV Species



	Study Areas	Salinity Range	Local SAV
1	Sassafras River (Lloyd Creek)	0-6 ppt	Wild Celery (<i>Vallisneria americana</i>) Eurasian Milfoil (<i>Myriophyllum spicatum</i>)
2	Severn River	5-14 ppt	Widgeon grass (<i>Ruppia maritima</i>) Redhead (<i>Potamogeton perfoliatus</i>)
3	Isle of Wight Bay (Route 90 bridge)	15-35 ppt	Widgeon grass (<i>Ruppia maritima</i>) Eelgrass (<i>Zostera marina</i>)

Fig 3 - PWC study areas and local SAV.

In addition, sediment displacement and SAV density and height sampling was performed before and after a PWC race in Isle of Wight Bay (Worcester County) behind the Ocean City convention center on 40th street. DNR staff worked with PWC race officials to locate portions of the race course where pre/post PWC race impacts could be examined. Divers placed calibrated markers at the corners of one square yard quadrats at the location of several severe turns on the marked race course and in a nearby control area in which no PWC activity occurred. The markers were designed to reveal if sediment deposition or excavation took place along the race path. In addition, plant density and height were measured from these quadrats both before and after the race.

Results

Assessment of low-level aerial photography

Low-level aerial photographs revealed extensive SAV scarring throughout the Isle of Wight bay areas. Overall, practically no SAV beds in Isle of Wight bay were devoid of scars. Four basic scar types were evident.

1 - Hydraulic Escalator Dredge Scars

The long, random scars are probably the result of hydraulic escalator dredge clamming, which was a legal activity in these areas until 1999. These scars are slightly more than 40" wide, typically 150' offshore and appear throughout the eastern shoreline of the coastal bays (Fig 4). These scars were in areas measured to be less than 5' deep at low tide. Since these near-shore locations are visited by a wide variety of hydraulic clam dredging vessels, in most cases it was impossible to determine the vessel primarily responsible for the scarring. Current regulations have created SAV protection zones in areas which have persistent coverage of SAV, essentially putting all SAV beds off-limits to hydraulic clamming.



Fig 4 - Scarring of SAV beds by hydraulic escalator dredge clamming in 1998. Scale: 1"=320'

2 - Teardrop Scars

Another type of scarring visible from the low-level aerial photographs are the dark colored, teardrop shaped scars present outside of marinas in “acceleration zones” (Fig. 5). When an outboard propelled boat accelerates from idle to planing speed, the lower unit is very close to the sediment and scours the sediment until the stern of the boat rises as the boat approaches planing speed. The scoured-out depressions appear dark colored because they fill up with macro-algae and SAV detritus. Buoys marking specified acceleration zones are effective in focusing this type of scarring into limited areas.

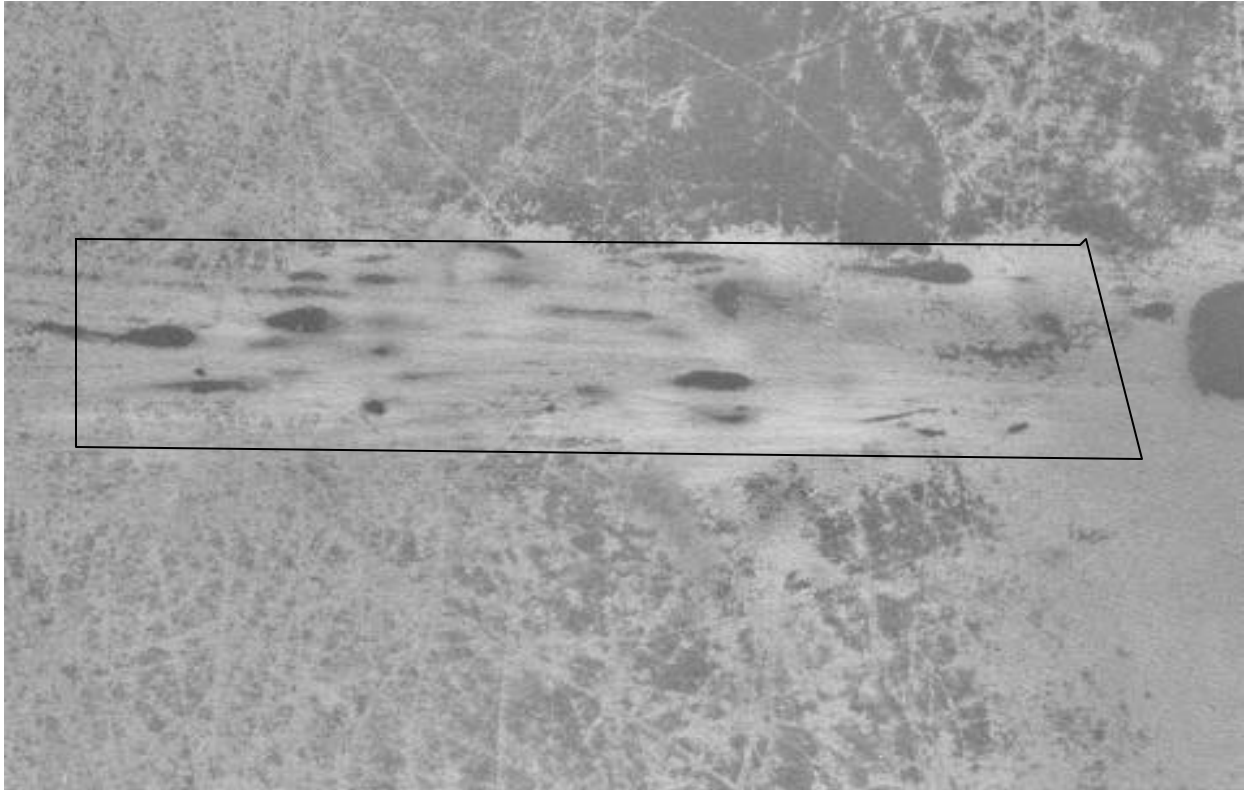


Fig 5 - SAV scarring in an acceleration zone outside a marina in 1998. Scale: 1"=160'

3 - Obliteration Scars

The third type SAV scarring noticeable in the low-level aerial photographs is the total obliteration of plants surrounding shoreline establishments in which patrons anchor their boats and wade to shore (Fig. 6). The obliteration of SAV is probably caused by a combination of concentrated boat anchoring, trampling and acceleration of outboard propelled watercraft. In 2000, the owner of the establishment placed mooring buoys and setup a water-taxi service to minimize SAV scarring in this area. Preliminary results of the effectiveness of the additional mooring buoys and water-taxi service are inconclusive.



Fig 6 - SAV scarring nearby a shoreline establishment in 1998. Scale: 1"= 160'

4 - Heavy PWC Traffic Scars

The only scarring that was directly attributable to PWC activity was adjacent to a PWC rental facility on 50th Street (bayside). This launching facility was used exclusively by PWC, and was subject to several hundred passes per day throughout the summer season. A large, persistent scar has been associated with this facility for the duration of our photographic investigation. Scarring of SAV at this location may be greatly enhanced by high numbers of high speed acceleration and/or trampling of riders mounting/dismounting PWC's in this area. However, it is noteworthy that the shallows surrounding the marked channel leading from shore to deeper water contained healthy SAV beds and was heavily vegetated (Fig 7).



Fig 7 - SAV scarring immediately outside PWC rental facility. Scale:1"=220'

PWC Field Experimentation

The controlled field experiments using PWC's in three different tidal areas with different SAV populations yielded consistent results. While PWC's did cause an increase to local turbidity (especially during high speed accelerations), shear velocities of water were apparently not sufficient to significantly displace healthy, rooted plants. At Isle of Wight Bay, test areas were subjected to three times the number of passes (60) and one area was even subjected to 20 minutes of repeated sharp turns, 180 degree reversals at full thrust in attempt to dislodge SAV. These extreme measures were unsuccessful in dislodging SAV. However, in all experiment areas where SAV leaves lay near or on the surface of the water, some clipping of SAV did occur as a result of being entrained into the PWC intake port (Fig 8).



Fig 8 - Surface SAV clipped by PWC.

PWC Race Impacts (Fig 9)

Direct observation of the quadrats revealed that SAV communities were intact, with little plant clipping or disturbed root material present in the test area (Table 1). Despite the very shallow water in which the race was run, which ranged from 24" to 36" in the tested areas, it was evident that little to no direct impact occurred along the race course following several thousand passes by PWC's.



Fig 9 - PWC rider during race in Ocean City, Maryland.

Table 1 - Isle of Wight Bay PWC race impacts on SAV

	Control (before/after)	Experimental (before/after)
Average SAV height (inches)	3-1/4" before / 2-1/2" after*	2-3/4" before / 2-1/2" after*
Average SAV density (0/low to 4/high)	2.4 before / 2.3 after	2.0 before / 2.3 after*
Sediment change (inches)	No change	N=29, 2 increase of 1-1/4", 1 decrease of 1-1/4", 26 no change

*Note: The small differences in plant height and density resulted primarily because of the difficulty encountered in relocating the quadrats, much of which appeared to be due to PWC crashes on the course that resulted in riders standing and walking in the sampling area. For both the control and the race course, not every quadrat was relocated following the race. Due to differences between quadrats, this could result in slight pre- and post-race variation.

Conclusions

Based on low level aerial photography and field experimentation, SAV does not appear to be substantially directly impacted by PWC's except under the following conditions:

- SAV leaves are clipped by the PWC jet pump intake when they lay near or directly on the waters surface.
- Long term PWC related activity (high speed acceleration and/or trampling of SAV by PWC operators in a confined area).

Damage to SAV from indirect PWC effects (turbidity, toxicity, etc) was not addressed in this study, and would require a much more exhaustive effort to adequately evaluate.

In observations based on aerial photographs, other types of scarring from other

recreational boating activity (acceleration and trampling) was common in shallow areas inside well marked buoyed channels. SAV areas immediately adjacent to the buoyed areas remained largely unscarred.

Recommendations

Based on our analysis of the impacts of PWC's to Maryland's Chesapeake and Coastal bays, we recommend using the successful approach developed and implemented by Florida for reducing recreational boating impacts to SAV (Sargent *et al.*, 1995) (Appendix 2), but modified to specifically address PWC in Maryland waters. This three point plan consists of PWC operator education, channel marking in high-use areas, and enforcement. Depending on the level of effort necessary to carry out these recommendations, additional funding may be required.

Education:

- PWC safety courses are already offered throughout Maryland, and tests are required for PWC rental facilities throughout Maryland. We recommend incorporating language specifically written to instruct PWC operators about how to identify and avoid SAV beds, and how to minimize SAV damage if they accidentally find themselves within a bed. Furthermore, PWC rental facility staff should describe local conditions to renters in such a way that they are able to avoid SAV beds. Signage at points of public access, and maps of SAV areas are another tool that should be employed.

Channel Marking:

- In areas where PWC use is high in the proximity of SAV beds, points of ingress and egress should be clearly marked to minimize the size of the area impacted.

Enforcement:

- Efforts undertaken to protect SAV from PWC activities will only prove effective if they can be effectively enforced. Regulations must be in place to allow Natural Resource Police officers to issue warnings and/or citations when PWC operators ignore channel marking buoys in high use areas.

References

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Sargent, F.J., T.J. Leary, D.W. Crews, and C.R. Kruer. 1995. Scarring of Florida's seagrasses: assessment and management options. FMRI Tech. Rep. TR-1. Florida Marine Research Institute, St. Petersburg, Florida. 37p plus appendices.

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Appendix

§ 4-213.1 (Requested study)

§ 4-213.1 Same - Impact of recreational watercraft activities [Section subject to abrogation].

(a) Definitions.-

(1) In this section the following words have the meanings indicated.

(2) "Study" means the study of the impact of recreational watercraft activities on submerged aquatic vegetation beds.

(3) "Submerged aquatic vegetation" has the meaning stated in § 4-213 (a) of this subtitle.

(b) Impact study.- The Department shall establish a program to study the impact of recreational watercraft activities on submerged aquatic vegetation beds in the Chesapeake Bay and coastal bays.

(c) Designation of habitats to be studied.-

(1) The Department shall designate a minimum of three separate submerged aquatic vegetation habitats within the Chesapeake Bay and coastal bays to be included in the study.

(2) Each designated submerged aquatic vegetation habitat shall have a maximum depth of 4 feet.

(3) The Department shall clearly mark each designated area with buoys.

(d) Study requirements.- The study shall:

(1) Evaluate the direct impact of recreational watercraft activities on the ecological value of submerged aquatic vegetation beds; and

(2) Evaluate the effectiveness of the Department's activities designed to minimize the impact on submerged aquatic vegetation habitats.

(e) Regulations.- The Department may adopt regulations to administer this section.

(f) Annual report.- The Department shall report the results of the study to the Governor and, subject to § 2-1246 of the State Government Article, to the General Assembly on or before January 1, 2003.

08.18.02.05 (Maryland Regulations pertaining to PWC's)

.05 Restrictions.

A. A person may not lease, hire, rent, operate, or give permission to operate a personal watercraft unless:

(1) The operator is 16 years old or older; or

(2) The operator attained the age of 14 years old or older and met the requirements of Natural Resources Article, §§8-712.2, Annotated Code of Maryland, as of January 1, 1996.

B. A person may not operate or give permission to operate a personal watercraft for the purpose of towing a person on water skis, aquaplane, or similar device, unless the personal watercraft:

(1) Has a capacity of three persons that includes the:

(a) Driver,

(b) Rear facing observer, and

(c) Water skier;

(2) Is specifically designed for water skiing by the manufacturer.

C. A personal watercraft operator born after July 1, 1972 shall carry a certificate of Boater Safety Education pursuant to Natural Resources Article, §§8-712.2, Annotated Code of Maryland.

D. A person may not operate or give permission to operate personal watercraft on the waters of the State, unless each person on board is wearing a Type I, Type II, Type III, or Type V personal flotation device approved by the United States Coast Guard.

E. A person may not operate or give permission to operate a personal watercraft on the waters of the State between sunset and sunrise.

F. A person may not operate or give permission to operate on the waters of the State a personal watercraft unless it is equipped with a self-circling device, or a lanyard-type engine cutoff switch.

G. Notwithstanding the requirements of §§F of this regulation, a person may not operate or give permission to operate on the waters of the State a specialty prop craft, unless it is equipped with a lanyard-type engine cutoff switch.

H. A person may not operate or give permission to operate on the waters of the State a personal watercraft equipped by the manufacturer with a lanyard-type engine cutoff switch, unless the lanyard is operational and attached to the operator of the personal watercraft, the operator's clothing, or a personal flotation device worn by the operator.

I. A person may not operate or give permission to operate on the waters of the State a personal watercraft equipped by the manufacturer with a self-circling device, if the self-circling device or engine throttle has been altered in any way that would prohibit the self-circling device from operating in its intended manner.

J. Within the Maryland waters of the Atlantic Ocean, a person may not operate or give permission to operate a personal watercraft at any time:

- (1) Within 300 feet of people in the water or surf fishermen; and
- (2) At a speed of more than 6 knots within 100 feet of a wharf, pier, or jetty.

K. On Maryland waters other than the Atlantic Ocean, a person may not operate or give permission to operate a personal watercraft on the waters of the State at any time at a speed in excess of 6 knots within 100 feet of a shore, wharf, pier, piling, bridge structure or abutment, or people in the water.

L. A person may not operate or give permission to operate a personal watercraft on the waters of the State at any time at a speed in excess of 6 knots within 100 feet of another vessel, except when required to maintain speed in a crossing or overtaking situation pursuant to the Federal Inland or International Navigation Rules.

M. A person may not operate a personal watercraft in a negligent manner. The following are examples of negligent operation and are not intended to limit the actions which may constitute negligent operation:

- (1) Jumping, or attempting to jump, the wake of another vessel, within 100 feet of the vessel;
- (2) Following within 100 feet of a water skier;
- (3) Weaving through congested vessel traffic;
- (4) Speeding on restricted areas; and
- (5) Operating a personal watercraft in a manner that endangers the life, limb, or property of a person, including the operator.

N. A personal watercraft livery owner, or the livery owner's agent or employee shall:

- (1) Prominently display these regulations governing personal watercraft.
- (2) Advise renters to read the regulations.
- (3) Within 30 days of the effective date of these regulations, add to the rental contract a statement that the renter or operator has read and understands the personal watercraft regulations. This statement shall be signed by the renter or operator, retained in the files of the livery operator for at least 30 days, and be made available to the Department upon request.

O. Personal Watercraft Sticker.

(1) An individual may not operate or give permission to operate a personal watercraft required to be numbered in this State on the waters of this State unless a regulation sticker supplied by the Department is attached to the personal watercraft.

(2) The sticker shall be attached to the upper half of the vessel in such a manner that the operator can read the information on the sticker.

(3) A personal watercraft livery owner, or agent, or employee may not sell, rent, or lease a personal watercraft in this State without the sticker attached in the manner required by this regulation regardless of whether the personal watercraft is required to be numbered in this State.

P. A person may not operate or give permission to operate a personal watercraft in excess of idle speed in any waters of the State less than 18 inches in depth, except when required to maintain speed in a crossing or overtaking situation pursuant to the Federal Inland or International Navigation Rules. It shall be a rebuttable presumption that the operator is aware that the depth of the water is less than 18 inches if:

(1) The area is marked as an idle speed limit area; or

(2) The operator was previously issued a warning or citation for exceeding idle speed in the same area.

Recommendations from” Scarring of Florida’s seagrasses: assessment and management options” (Sargent et al. 1995)

Four Point Approach

Ample justification now exists to reduce scarring of seagrasses. A multi-faceted approach is necessary to deal with the wide variety of user-groups, activities, and types of physical perturbations. Below is a four-point approach, used by some local governments (e.g., Barker and Garrett 1992), that can form the basis for an effective statewide management program. Effective implementation of this comprehensive approach in plans designed for specific locales should initially reduce seagrass losses at *moderately* and *severely* scarred sites and slow the increase in scarring at sites having only light scarring. Modification to management programs developed for specific areas should reduce seagrass scarring, over the long term, to levels that do not significantly affect habitat quality.

1. Education

Education is an essential part of any effort to make all boaters – tourists and residents alike – understand the sensitive nature of Florida’s shallow seagrass communities. Florida, with its millions of visitors each year, is one of the most popular boating, diving, and fishing destinations in the world. These boaters can be educated through informative pamphlets available at marinas and boater-registration locations; through boating classes; through boat-user’s guides and maps, through public-school seminars; through signs at launching ramps, and through organizations such as the Florida Conservation Association (FCA), the Organized Fisherman of Florida (OFF), and the U.S. Coast Guard Auxiliary and Power Squadron (Kenworthy et al. 1988, Barker and Garrett 1992, Folit and Morris 1992). Shallow-water fishing guides and commercial fisherman – who have strong interests in the health of Florida’s seagrass resources – should use peer pressure to reduce any scarring that is caused by their user-groups. Power Squadron and Coast Guard Auxiliary boating courses should include educational information on the importance of seagrass beds and should emphasize their protection as part of a safe-boating curriculum.

In areas where new visitors and seasonal residents are in continual flux, however, additional approaches to accomplish resource-management goals should be explored. Government agencies need to be persistent in communicating, the problem of seagrass scarring to the public. Single-year efforts do not have the same effect on seasonal populations – which change year to year – that long-term, regular programs do. Aerial photographs that show scarred seagrass beds in graphic detail have proven useful in education managers, decision-makers, and the public. This approach could be used to communicate seagrass protection needs to seasonal residents and tourists at areas they are likely to visit (e.g., at boat-launching ramps). Communication the need to limit the size, draft, loads (tonnage), and power of vessels in shallow seagrass beds is an important educational goal.

2. Channel Marking (Aids to Navigation)

Conventional USCG-approved markers are helpful in deeper channels, but markers should be located away from the edges of shallow seagrass flats to provide a wider buffer against scarring. Markers should be gated (paired) in most locations and should extend well beyond

the ends of channels. Marking channels clearly – especially with easily visible, reflective arrows – will benefit all boaters by showing them the correct passage, which would improve boating safety and at the same time minimize incidental scarring of seagrasses by boaters who stray out of unmarked channels.

Simply, easily installed and maintained markers with reflective directional arrows could be effective deterrents to seagrass scarring but may not conform to official USCG requirements. The channel-marking system used by Everglades National Park has directional arrows and is successful, but it needs some refinement (Skip Snow, personal communication). Monroe County has addressed the need for additional channel marking through their Department of Marine Resources, which released a draft Boating Impact Management Plan (Barker and Garrett 1992). It will eventually be incorporated, in part, into the management plan for the Florida Keys National Marine Sanctuary (FKNMS).

As channel-marking criteria are established and new markers are put in place, illegal aids to navigation should be removed. Often, channels are prop-dredged through seagrasses and between mangroves, even though an existing channel is available just a short distance away. In some cases, existing prop-dredged channels should be closed off by installing reflective pilings to block access and thus allow scarred seagrasses to recover. The benefits to the resource brought by an effective channel-maker system are negated if illegal markers and prop-dredged channels are allowed to proliferate.

3. Enforcement

Voluntary compliance has not proven effective in the past in resolving many resource-damage problems. Prop-dredging and other vessel related damage to seagrasses should be viewed as destruction of protected public resources and as a form of unsafe boating. Past actions by all levels of government provide legal authority to enforce rules and regulations prohibiting prop-dredging (e.g., U.S.A. and *FDER v. M.C.C. of Florida and Michael's Construction Co.*, Case No. 81-2373-CIV-EBD, Southern District of Florida). Citations and warnings for scarring seagrasses must be issued if an enforcement program is to be effective. Scarring of seagrasses would be substantially reduced, without placing undue hardship on the boating public, if existing legal authority were fully exerted.

Scarring of seagrasses is often willful, particularly when it is repetitive. Florida has laws that can protect natural resources from willful and reckless damage (e.g., Reckless or careless operation of a vessel. F.S. 327.3; "Duty of the Board of Trustees of the Internal Improvement Fund to protect, etc., state lands...", F.S. 253.05; "State attorneys, other prosecuting officers of the state or county...county sheriffs and their deputies..." to assist in protecting state lands F.S. 253.04; and even F.S. 380.05, "Areas of critical state concern..."). The Florida Administrative Code, chapter 18-14 discusses fines for damaging state lands.

4. Limited-Motoring Zones

Programs initiated by the FDEP, the U.S. Fish and Wildlife Service, and several counties use moderate restrictions, such as idle-speed or limited motoring zones, to protect sensitive resources while allowing public access compatible with environmental protection. Shallow channels, flats, and embayments near developed areas should be protected before scarring problems become severe. Areas set aside as preserves could be incorporated into a zoning program that limits certain types of access and offers protection (Barker and Garrett 1992).

Weedon Island State Preserve (Pinellas County) has experienced a 95 percent reduction in the numbers of scars since it was closed to combustion engines – electric trolling motors are still allowed – in October 1990 (Folitt and Morris 1992).

Limited access and closure are effective ways to reduce the scarring of seagrass beds; however, many issues must be considered when closing areas to watercraft. Work groups or task forces should be created to address issues that concern areas being considered for limited access or closure. Boating-effects studies, boating-use surveys, and collaboration with affected parties must always be considered. Involving all sides in planning at the beginning is imperative when closing an area to powered vessels. Task forces such as the one for Cockroach Bay Aquatic Preserve (Cockroach Bay Seagrass Task Force 1992) and the one for Fort DeSoto Park in Pinellas County are good examples of cooperation among user-groups in formulating boat-access restrictions to protect seagrasses.

The seagrass-management plan for Cockroach Bay Aquatic Preserve, located on the eastern shore of Tampa Bay, was implemented by Hillsborough County in August 1992. In certain areas, the plan limits vessel access and prohibits the use of combustion engines in waters that are less than 18 inches deep at mean low water. Also, the public is being educated using a number of approaches, (e.g., through signs, posted at boat-launching ramps, that discuss seagrass protection). Channel markers will eventually have depth information posted. Law enforcement was increased in the preserve by adding a Hillsborough County Sheriff's Deputy and by deputizing the manager of the preserve. Seagrass recovery from scarring is being studied, and aerial photography is being used to monitor the amount of scarring in the preserve (Cockroach Bay Seagrass Task Force 1992).

Despite these steps, however, initial reports of their effectiveness are in some respects disappointing. Scarring extents in Cockroach Bay have increased by about 5000 linear feet in the first years (Dawes et al. 1994). Also, around entrances to the preserve, approximately 145,000 square feet of additional scarring was discovered, despite its cryptic nature (i.e., hidden by sedimentation). Overall, an additional 3.3 acres of seagrasses were scarred in one year within the preserve. In some areas of the preserve, voluntary compliance has not worked, and total closure has been implemented to alleviate scarring. Managers are looking into further measures to reduce scarring losses, such as proactive restoration and more rigorous regulation.

Pinellas County is implementing a similar program for Fort DeSoto Park, which is near the mouth of Tampa Bay. Motoring has been limited or completely restricted in some areas. Fort DeSoto Park has three types of limited-motoring zones: 1) *slow/minimum-wake zones* are intended to improve safety and reduce boat-wake effects, 2) *seagrass caution zones* inform of seagrass presence and encourage caution in boating, and 3) *boat-restriction zones* allow only poling and electric motoring. As in Cockroach Bay Aquatic Preserve, semiannual aerial surveys will be conducted so that changes in seagrass densities and scarring can be monitored and photographed for analysis. A final report is being prepared on the effectiveness of the program.