NOAA Integrated Ocean and Coastal Mapping Seafloor Mapping Standards October 2011

This document provides a set of guidelines, based on the International Hydrographic Organization's (IHO) Order 1 standard, for the collection and processing of seafloor mapping data such that they may be used confidently by any NOAA program. Adherence to these guidelines will allow products from hydrographic or fisheries surveys to be used for either nautical charting or essential fish-habitat mapping purposes. These guidelines are aligned with the NOAA Integrated Ocean and Coastal Mapping (IOCM) concept and resulted from a workshop on Coastal Seafloor Mapping Standards, held in April 2006 at the Joint Hydrographic Center, University of New Hampshire. The workshop included representatives of NOAA organizations with seafloor mapping missions.

This document is intended to guide the collections of Sonar and physical data such that it may be most useful to the largest number of users requiring seabed mapping and classification products. The scope of this guideline covers single beam sonar, multi beam sonar, interferometric sonar, side scan sonar, Lidar, physical seafloor samples, optical seafloor samples and detached positions for objects. To optimize the value of seafloor data the guidelines tabulated below should be met when and where it is deemed to <u>not interfere with the principal mission</u>. Data collectors may choose to surpass the guideline specifications in terms of data quality and range accuracy and precision. These guidelines are intended to cover the technical requirements of data collection only. It is the responsibility of the project manager to ensure compliance with all administrative, environmental, permitting or other federal/state compliance issues that may occur during the project planning and execution.

These guidelines are relevant for surveys in water depths greater than 5 m, and extending to the limits of the continental margin. In depths shallower than 5 m, single-beam, side scan, or interferometric sonar, Lidar, or aerial/satellite imagery should be used.

The guidelines are not conditions for the acceptance of seafloor mapping data by a NOAA data center. Incomplete adherence to these guidelines due to variations in resources (e.g., time, equipment, corrections, or expertise to collect and processes seafloor samples) does not negate the inherent value of the seafloor data. Long term, NOAA should endeavor to make the resources needed to meet these standards available on all available platforms.

Guidance for seafloor mapping projects can be provided through the various efforts of the offices of Office of Coast Survey (OCS), Joint Hydrographic Center (JHC), Center for Operational Oceanographic Products and Services (CO-OPS), National Centers for Coastal Ocean Science (NCCOS), National Geodetic Survey (NGS), National Environmental Satellite, Data, and Information Service (NESDIS), Nation Marine Sanctuaries, and the six regional Fisheries Science Centers of the National Marine

Fisheries Service (NMFS). Project planning, development, execution and data storage are all important elements in ensuring a successful seafloor mapping project. For the best project coordination, one or more of these offices should be included in the planning stage at least one year prior to any anticipated data collection. This would ensure the broadest range of partners and collective project success.

For additional technical information and guidance, consult the NOS Hydrographic Specifications (http://www.nauticalcharts.noaa.gov/hsd/specs/SPECS_2011.pdf).

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NOAA IOCM Seafloor Mapping Guidelines

Specification	Guideline
Sonar frequency	Depth Range (m) — *Frequency (f; kHz) 5–100 — 240<f≤–450 50–200 — 180<f≤240 200–1000 — 50<f≤180 1000–3000 — 12<f≤50 3000–12000 — f ≤12
Sampling coverage	Full coverage with 5% overlap. Reconnaissance-style mapping may be necessary due to time constraints.
Resolution	2 m resolution in 5 m to 40 m depths; 5% of depth beyond 40 m
Depth reference	Depth is measured from the sensor face. For sonars deployed from submersibles, the estimated depth of the transducer face depends on the delay from the last GPS-estimated position and account should be made for inertia-sensor drift.
Depth uncertainty	95% probability level, after corrections for systematic error, e.g., water level, $= \pm\sqrt{[a^2 + (b*d)^2]}$, where a = 0.5 m, b = 0.013, and d is the depth (= 0.5 m at 5 m depth, and = 2.6 m at 200 m depth)
Vertical Reference	Depths should be referenced to the appropriate Chart Datum (e.g., Mean Lower Low Water or Low Water Datum in non-tidal areas), or WGS 84 ellipsoid, and consider tide predictions, water level observations, datum references and zone corrections. The practical minimum for water level error is 0.20 m and allowable maximum is 0.45 m at the 95% confidence level. Coordinate, in advance of surveys, with the National Ocean Service's (NOS) Center for Operational Oceanographic Products and Services (CO-OPS), to prepare tidal zoning charts. This may require the installation of water level gauges or, in areas where water level gauges or shore-based kinematic GPS are not available, the installation of specialized GPS equipment on the survey vessel and subscription to specialized globally-corrected GPS (GcGPS) services. Platforms with inertial motion unit (IMU) systems should record the raw data input to the IMU.

Horizontal Reference	Positions referenced to WGS 84 (NAD 83)
Horizontal uncertainty	95% probability level, after corrections for systematic error, e.g., water level, =5 m + 5% of depth (5.25 m at 5 m depth = 0.003 latitude min, 15 m at 200 m = 0.008 latitude min.)
Backscatter	Collect over the full-depth range. This is dependent on the sonar-system's capability. If constrained by data storage capacity, reduce the sampling rate or store only average beam intensities.
Classification ground truth	Optical or grab samples sufficient in quality and quantity to ground truth areas of backscatter differentiation, and not to exceed a lateral spacing of 2000 m. Unless required by the primary mission, optical or physical sampling of the seafloor is not required in depths exceeding 100 m.
Metadata	Minimum FGDC compliant; ISO 19115 preferred.
Archiving	Raw and processed geophysical data, with metadata, should be submitted to National Geophysical Data Center (NGDC) within 1 year of acquisition. Additional oceanographic data should be delivered to the National Oceanographic Data Center (NODC) also within 1 year of collection. Raw data is in the form generated by the sensor, without corrections applied.
Sound speed profiles	Sound-speed profiles are needed to correct soundings for refraction. These should be measured with casts of a Conductivity, Temperature, and Depth sensor (CTD), a Sound Velocity Probe (SVP), or an Expendable Bathy Thermograph (XBT). Depending upon the type of mapping project and the time spent in a location, sound speed profiles samples could be obtained at various intervals with single beam sonars typically needing fewer corrections than multi beam sonars. Casts may need to be made frequently, e.g., 2 hr or less, in areas of increased water column variability, such as areas of high tidal ranges, river deltas, or fresh-water outflows. Profiles may be estimated using XBT data, while in transit collected at least twice a day in open-ocean and more frequently (e.g., 4-6 casts per day) in continental-shelf areas. To estimate sound speed profiles from XBT data, the depth-averaged mean salinity from a nearby CTD cast should be used to compute sound speed and *not* the salinity measured at the sea surface. For sound speed data collected during transits, a few casts may not provide accurate ray-tracing solutions; these may be used, however, to bracket the estimates of uncertainty due to refraction. For beam-steering sonars, measurements of sound speed should be made continuously at the location of the sonar transducer.

Patch tests	Conduct semi-annually, after any disturbance of the sensors, or when data quality is questionable. Multi-beam patch-test procedures are described in the NOS Hydrographic Specifications, section 5.2.4.1. An example of multi-beam spherical water column patch test procedures are described in the Simrad ER60 Operators manual on page 20 located at WWW.Simrad.com/Products/Scientific products for fishery research applications/Echo Sounders/Simrad EK60/documents/Simrad ER60 Operator manual Rev. C. Single beam navigation timing error test procedures are the same as those listed for multi-beam in the NOS Hydrographic Specifications.
Ancillary sensors	Sensor offsets should be measured with accuracies and precisions to within cm level. Sensors (e.g., SVP, CTD) should be calibrated at least annually.