

ENSURING ESA FIELD COMPLIANCE IN CONSTRUCTION THROUGH MULTI-MEDIA EDUCATION ON CD

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ABSTRACT

This paper discusses the creation of multi-media CDs to assist civil engineers in design and construction of highways with recognition of the increasingly stringent requirements laid out by the Endangered Species Act (ESA). Under FHWA sponsorship Portland State University was required to study the possible marriage of computer learning technologies; using videographers, animators, and software designers, to the real world engineering design and site 'feel' of construction activity using environmental construction experts on camera, and to include case histories. The result is a 100% digital and portable CD product with multi-media techniques designed to supplement more cumbersome paper and written word formats. This offers a new way to overcome civil discipline barriers, and with web on-line components quickly connect the engineer to current information, ensuring the CD is never outdated. The paper introduces and defines the 3 possible categories for this media technique to build future digital civil engineering libraries: Category I, II and III, each having different learning methodologies and formats.

INTRODUCTION

Delivery of timely appropriate knowledge and appreciation of the dynamic nature of social, legal and technical interaction, both in design and in the field, demands the civil engineer stay informed. The chronologically early site investigation, drilling and logging practices of the geotechnical engineering community places them in the vanguard of those activities which must comply with the ESA, especially in sensitive

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locations, such as highway corridors and pipeline routes. With ASCE's banner call, '*Building the Quality of Life*', civil engineers inherit the obligation to protect our diverse environment; thus construction activity must be planned, designed and executed with the highest possible regard for the environment. For highway and infrastructure construction federal agencies have been assigned a special leadership role to demonstrate best geo-environmental construction practices. Close communication with these agencies is now essential.

Technical boundaries between the geotechnical, highway, project planning, and the environmental disciplines must be removed to implement this multi-discipline law. Further, this discipline interaction often is site specific to regions of the country where states have high numbers of endangered and threatened listed species. For the geotechnical engineer, and site representatives, approval of contractor access roads, choosing soil cut and fills locations, and stream and river bank erosion issues etc., all must be resolved within the ESA on affected project corridors.

The Endangered Species Act

The ESA was created under President Nixon's administration in 1973 under Act of US Congress, Section 1531, and designed to save species and their habitats. A continual national debate has been underway ever since Congress moved to protect animal and plant species that were either threatened or their survival endangered. ESA enforcement includes protecting habitat as well as the species and significantly impacts civil infrastructure planning, permitting, design and especially construction - which is the focus of this paper. Many construction projects do have some impact and result in, so called, *Section 7 Consultation* procedures under the Act. Some projects obtain special permits that allow limited 'incidental take' that must be approved by the regulating federal agency. Based on the project's location, a different mix of local, state and federal agencies are involved in technical permitting.

There are two agencies designated by Congress to enforce the Act. The first is the National Oceanic and Atmospheric Administration - Fisheries Branch (NOAA-Fisheries) in the US Department of Commerce. NOAA-Fisheries has a mandate to conserve, protect, and manage Pacific salmon, groundfish, halibut and marine mammals and their habitats under the ESA, and other laws. Thus, they have prime responsibility for all marine species. The second is the Fish and Wildlife Service (FWS) in the Department of the Interior. They have prime responsibility for terrestrial species and share with NOAA-Fisheries responsibility for migrating fish. With an extensive World Wide Web outreach, the FWS detail a wide range of activities to carry out their ESA mandate including: publishing an Endangered Species Bulletin, partnership with individual states, a consultation program, and maintaining and updating the species listing.

For the Pacific Northwest, the National Forests have been the subject of high profile national attention around the listing of the Spotted Owl and numerous trout and salmon, among others, resulting in stricter limits on logging these lands. To mitigate the habitat damage effect, the US Forest Service has proposed 550 designated Spotted Owl habitats in the Northwest. Regulations in 1992 declared 6.9 million acres protected in Oregon, Washington and California. These restrictions produce special

constraints for highway and other infrastructure construction. The Act makes it unlawful to 'take' protected species and their habitat and serious criminal and civil penalties can result if no 'incidental take' permit has been granted. Many states have additional measures in addition to federal law. Violations of the "take" provision in the ACT calls for up to \$50,000 fine and up to one year imprisonment. Most other ESA violations call for criminal fines up to \$25,000 dollars and up to 6 months imprisonment. The role of the highway field engineering construction staff in ensuring a contractor is complying with the law is of paramount importance.

HIGHWAY CONSTRUCTION ISSUES AROUND THE ACT

In theory, the ESA is a simple piece of legislation but complex in construction practice. A large and growing body of scientific knowledge is available to help guide the civil engineer and mitigate possible violations during construction activities. It is essential for any geotechnical engineer working around highway construction to be familiar with permits, the Act, and knowledge of the most common terms, acronyms and definitions. The Environmental Crimes Section of the United States Justice Department in its first nine years of operation has indicted 838 individuals, levied \$74.5 million in fines and penalties, and imposed more than 173 years of jail time for all types of environmental violations. At least 47 people have been indicted for wetlands violations, and five people have been sentenced to prison. Ignorance is no defense!

The regulatory agencies' detailed response around endangered species and their habitat, together with very specific requirements, are contained in the regulatory agencies' Biological Opinion issued for a project. Before construction begins considerable effort, sometimes lasting years, has been expended to liaison with all associated agencies around the ESA. In addition, very specific requirements have been agreed upon under the ESA *Section 7-Consultation* with both NOAA-Fisheries and FWS. The geo-environmental final success of the project depends on the agency engineering staff and contractor's knowledge base of all these provisions to ensure full compliance with the law and to stay exempt from the prohibitions of Section 9 in the Act. The federal funding program under Emergency Relief Federally Owned (ERFO) road projects in particular, are likely to combine fast track design and construction. These projects confront geographical issues around remote locations such as: bridges over streams and creeks, forest slopes, wetlands and limited highway construction weather windows.

Federal work always attracts contractors with a range of experiences and competencies making it paramount for the site engineering staff to be cognizant of possible violations and scope for claims around ESA issues. Typically four general concerns appear on all highway contracts: noise, concrete operations, sediment runoff and handling of contractors plant fuel, fluid and grease. For example, contractor's earth moving plant and haulage are powerful diesels that record high decibel levels which may exceed maximums permitted in certain time periods for listed species, e.g. during nesting. In addition, concrete grout is toxic to many aquatic species making grout escape and concrete spills a serious concern. To stay in compliance with the Act all formwork joints must be carefully sealed. Geographic remote locations call

for very specific fuel delivery routes with detailed handling and storage. Late contract modifications as a result of identifying potential ESA violations can also result in significant highway contract cost overruns.

The challenge for the civil engineer is to access appropriate and helpful information in a timely and effective way by exploiting all communication technologies. In the new 21st century the knowledge access solution will come increasingly from digital techniques employing laptop and notebook p.c.

DIGITAL METHODOGIES AND FEATURES

Digital storage and distribution of information for the current generation of laptop and notebook computers can be in either Digital Video Disk (DVD) or Compact Disk (CD) formats. At present the Adobe Acrobat® .pdf file format is increasingly employed to provide a reliable and formatted digital representation of text reports including specifications and permits, but only solves the bulky paper problem and is less effective for teaching and does not provide current information on a dynamically changing topic such as the ESA and its impact on construction projects. Disk space requirements vary greatly depending on the type digital media being incorporated ranging from small files for the written word, to medium sized for graphics and animations and very large files for video streams using Windows Media Player, QuickTime, or Real Player.

The current version of the ESA training disk (discussed below) uses a double CD to present the required mix of text, animation, video, and audio for the topic providing approximately 3 to 4 hours of viewer material. A CD with these features can be designed for both on-line and stand-alone use by the inclusion of hypertext which activates web browsers on the pc. The range of digital tools available to convey knowledge to the engineer and field staff is impressive.

- *Linked Navigation:* for rapid access throughout the product.
- *Videography:* edited to experience construction techniques and processes.
- *Expert Speaks:* studio quality recorded FAQ sessions for the voice of experience.
- *Animation:* to illustrate key terms, best practices and/or site procedures.
- *Roll-Overs:* mouse activated overlay expansion screens of diagram and figures.
- *Interactive Decisions Trees:* to provide structured decisions to deal with possible unexpected construction scenarios.
- *Stills and Text:* linked via the navigation structure to other areas of the CD.

With some highway projects adding wireless capability for Internet connection and real-time data transmission, the web accessibility can now enhance ESA information capture. This feature is particularly useful for the ESA topic in seeking updates from the NOAA-Fisheries and FWS on species categories, as well as updated weather forecasting.

When assessing civil engineering needs around highway projects, three possible categories of digital CD products emerge:

Category I. These are the interdisciplinary topics that may be site specific. They require a broader level of review, demand update technologies to remain fresh and applicable, and may include legal content with review. The ESA CD product described in this paper is an example of this category.

Category II. This category represents the conversion and enhancement of existing reports, usually in text and figure formats, to help field inspection of highway construction projects and which have no design component. With the increasing sophistication of geo-technologies developed directly by specialist contractors and increased agency outsourcing, a need exists to prepare the field inspection engineering staff to understand and contribute effectively to QA/QC demands. Existing reports from lead federal and state agencies, such as FHWA and the US Army Corps of Engineers, contractor associations and the international community, are often available. The Portland State Group have previously completed 2 products under this category (Smith and Barrows, 2003)

Category III. Represents products especially for the practitioner design community, where new knowledge from research work must be extracted, 'shaken-down', summarized and implemented for advancement of state of practice. At present this activity has no formal mechanism or designated agency, and in some cases does not occur at all. Thus the investment in the research is lost without effective transmission to the practitioner.

The next section describes the history and developments of a two CD pack to enhance the training of highway field inspectors around the ESA.

COMPACT DISC DEVELOPMENT '*Build Smart*'

Under Western Federal Lands-Highway Division (WFL-HD) sponsorship, Portland State University was required to study the marriage of computer learning technologies to the real world highway site 'feel' of construction activity. Serving the needs of Oregon, Washington, Idaho, Montana, Wyoming and Alaska, WFL-HD, a branch of FHWA, has an enviable reputation in environmental leadership, innovation and construction practice. As a full service agency, they administer the planning, design and construction of forest highway system roads, parkways and park roads, Native American reservation roads, defense access roads, and other federal land roads. Some of this work includes design of low volume roads through environmentally sensitive land; terrain that is both rugged and pristine. Emergency repair maintenance, and improvement of the fills, slopes and retaining walls, especially after high rainfall, calls for careful consideration of the environmental factors under National Environmental Policy Act and the Clean Water Act. WFL-HD field engineering staff plays an increasingly important part in maintaining their reputation in working with the ESA and the contractor. All field inspectors are on the front line ensuring full compliance with the Act and maintaining the leadership role mandated by Congress for federal highway agencies.

To provide rapid access to a summary of ESA knowledge in remote locations, the digital CD medium was chosen with the subtitle *Build Smart*. The CD is designed to

acquaint highway engineering staff personnel with the ESA and to help them direct their contractor to build smart. It covers an introduction to the Act and its implications, a review of terms and definitions as they monitor a construction project with the Agencies plans, permits and specification, a look at the ESA resources back in Vancouver, specific construction concerns and two extensive case histories.

A Technical Working Group (TWG) was formed with responsibility to guide the product through development of its Alpha and Beta stages prior to final issue of Gold version. The production of digital multi-media is quite different to the preparation of a hard copy Technical Report or Design Memorandum, where simple cut and paste of sections is often used. Multi-media productions use intensive digital techniques to create the most appropriate learning methodology to communicate material efficiently and optimize learning. In the Alpha version, only the organization of the material is checked by the Navigation Controls and a few examples of the media style are shown to the TWG. After incorporation of changes from the Alpha exercise in sections and subsections, they then become fixed for the rest of the CD development.

The on-screen look of the two CD pack is illustrated in Figure 1 following a natural Windows® environment user control. (Note: the authors recognize possible poor readability of the screen image figure - Director® created images are full color and exist digitally for screen display, but here do convey the essence of the CD product).

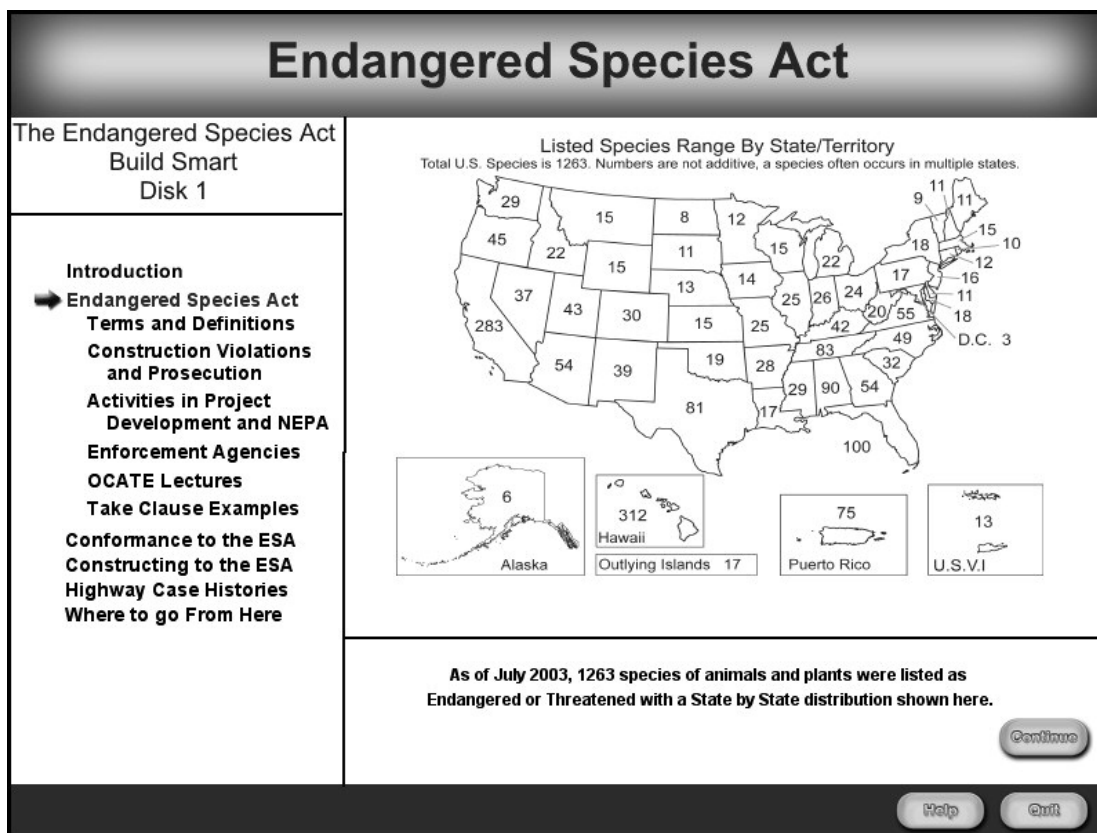


FIG. 1 Image Illustrating Navigation Control from the CD

On the left hand side can be seen the major section content list with the section the user is presently exploring expanded into its sub-sections for easy navigation reference. Showing on screen is a recent state-by-state breakdown available at the website for FWS of the 1263 species of animals and plants listed as Endangered or Threatened. Just a mouse click control lets you continue in this section or move back to the main navigation area on the left hand side enabling the user to quickly transfer to all other parts of the CD. When media player videos run within the section, control is available to rewind, pause or fast forward. By design, the product works equally well as a first time thorough introductory source to the topic, and also as a complete reference work for future contracts, both in the office and out in the field.

Due to the visual and dynamic nature of the material, this project was heavily dependent on audio and video sequences. Audio and animation files are smaller than video files, but still quite large. To remain practical this project required the use of two 640 MB CD to deliver the product, so the multi-media design teams were faced with an enormous space problem to provide the highest quality presentation while preserving disc space. An optimum compromise was found between screen size, frame rate, and resolution. After much experimentation the team found they could make a good quality video by reducing the frame rate of the video to 15 fps from the standard 30 fps thereby reducing the size of the video frame from full screen to one-quarter screen. Macromedia Director® was used to develop the project allowing seamlessly intermix video, audio graphics, graphical user interface and learner assessments.

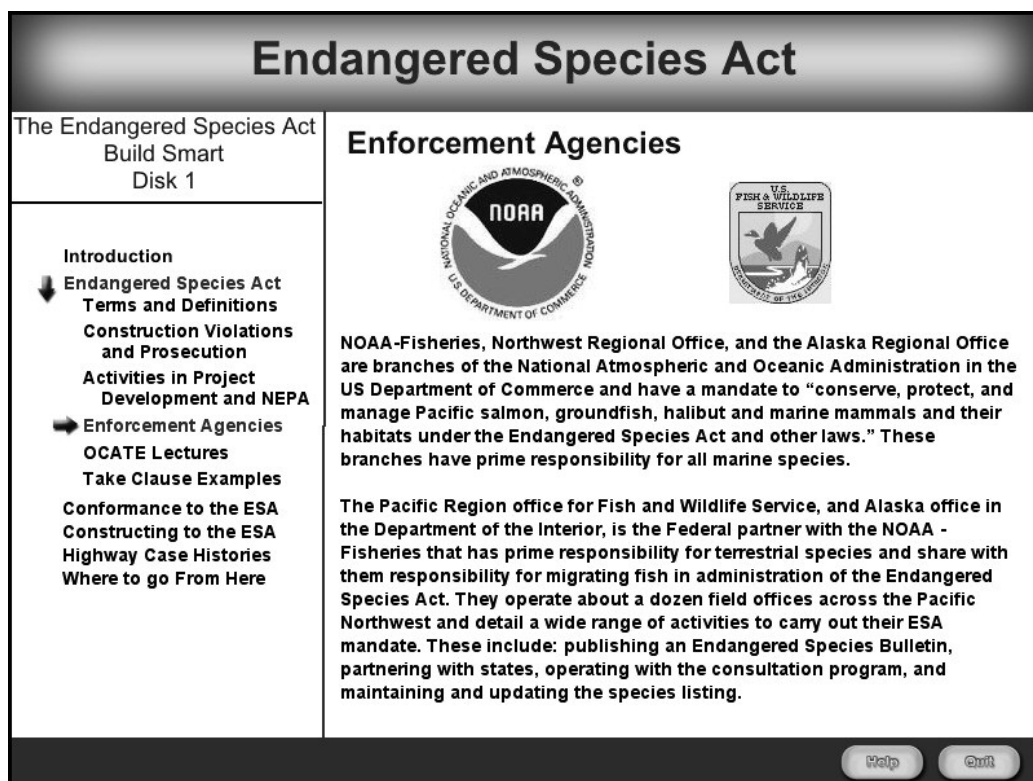


FIG. 2 NOAA-Fisheries and FWS Internet Linked Images from the CD

The more dynamic and expanded features appear when the User is online and the mouse clickable links opening the p.c. web browser. For example, the most up to date information around listed species from the two enforcement agencies web sites can be accessed using hypertext images, illustrated in Figure 2.

The range and diversity of valuable resources for highway construction around environmental issues continues to expand. In the spring of 2002 the Oregon Center for Advanced Technology Education (OCATE 2002) a branch of the Oregon University System, sponsored three lectures on highway design and construction to the ESA. Extracts from these lectures appear on the CD. The first speaker represented NOAA-Fisheries, the second speaker presented the private consulting sector issues and the third speaker discussed the public agency viewpoint. In addition, the CD has on-line links opening the user's p.c. web browser to provide the full lecture via video streaming from the OCATE servers.

Minimum hardware and software requirements are: Windows® based pc running a Pentium© III processor at 1.2+ GHz, 128MB of RAM, sound card with speaker, standard X VGA video, and of course a CD-ROM and/or DVD drive. The operating system should be Microsoft Windows® NT, 2000 or XP.

SUMMARY

To avoid violations of law with serious consequences, geo-environmental issues require high competency and excellent communication to be established early between the contractor, highway agency and the regulatory authority. At all levels of our culture, communication has now been revolutionized by the widespread availability of computers including dissemination of research recognizing the diversity of technical topics in engineering. The Civil Engineering Multi-media Project at Portland State University has now proven its application by the technical presentation in two of three identified categories, in Category 1: ESA issues, and in Category 2: Soil Nailing and Ground Anchors. It is anticipated all three modules, including the ESA application described in this paper, will be available in the summer of 2004 from FHWA. Each contains a web link for survey feedback which will provide multi-media designers information to further improve the CD digital library series. To continue to close the gap between knowledge and practice expanded use of digital formats are encouraged.

REFERENCES

OCATE (2002), 'Civil Engineering Lectures' Three ESA Lectures Video Streamed under Civil Engineering at http://www.ocate.edu/1_archive.php#, Oregon Center for Advanced Technology Education, Oregon University System

Smith, T.D. and Barrows, R. (2003). "Multi-Media Review of Ground Anchors and Soil Nails from a CD", *Foundation Drilling*, ADSC, 23(4), May, pp21-24